POWER

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Taxing the Educator of the People

WHERE did you learn what you know? You learned some things in school, and some of them have stayed with you. Some, almost forgotten, which seemed of little importance then, have come back with new significance when you found their application to living.

You have learned some things by having to do them, by observation and experience, by contact and conversation with your fellows.

You have learned some things by listening in at lectures and sermons, at meetings of your society, and the part you have taken in its discussions.

But is it not a fact that a good big part of what you know, especially of modern practices and methods and developments and people, of what is going on in the world, in your own business, you get by reading?

Did you ever try to conceive the mental condition of the man who cannot read, who has never been to school whose concept of things is based upon simply his own contact and experience? Is it any wonder that masses of such men have been led by the knowing and ambitious into some of the deplorable exploits of recorded history?

The broad dissemination of knowledge began with the printing press, and with its dissemination accomplishment grew apace. When the millions of possible inventors and discoverers and promoters were able to set out with a knowledge of what had been already accomplished, it was easy to take the next step. When a difficulty was encountered, the widely published necessity for the solution of that problem set experts to work upon it all over the world.

There is so much knowledge in the world today that nobody could absorb it all. There is so much of new thought, of the results of research, of record, of new accomplishment, of the revamping of sciences and arts and processes in accordance with progressive discoveries, that in order to attain to any proficiency in one branch one must confine oneself to it to the neglect of others.

As a result there is specialization and each specialty has its literature and usually its periodical, and it is upon these periodicals that the practitioners or followers of a specialty are dependent for their knowledge of at least the current state and activities of their subject.

The more of the right kind of literature there is accessible to a people, and the more cheaply and easily it may be had, the more intelligent, the more capable of self direction, the safer against being led off after false idols, the more efficient in carrying out their daily work and stabilizing the prosperity and comfort of the nation will that people be.

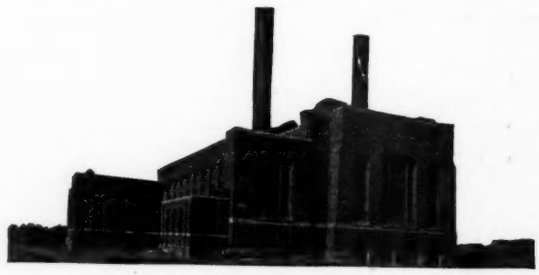
To hamper a people's reading is a socio-political blunder.

In the time of its need for war purposes the Government raised the postage rate upon periodicals. Last year it collected twenty-five and a half million dollars against less than twelve millions in 1918. Some papers have been forced to suspend publication, others to abandon the mails and resort to other means for a less general distribution. Still others have ceased to solicit subscriptions in those zones the postage to which is prohibitive. Most of them have been obliged to raise their subscription prices.

The war cost a great deal of money and several generations will have to bear its burdens, but it is not for the general good to make them bear too heavily upon the circulatory system through which the people are kept in touch with the world's best thought, which enables them to spend their money to the best advantage and stimulates the buying upon which the return of prosperity so much depends.

Calumet Station, Commonwealth Edison Co.

INITIAL installation, 60,000-kw. Steam supplied to turbines at 300 lb. pressure and 200 deg. superheat. Seven 15,089 sq.-ft. boilers designed for 350 lb. and 250 deg. superheat. Forced-draft chain grate stokers. Heat balance maintained by exhaust of steam-driven auxiliaries and by bleeding main turbines. Steel economizers installed. Separation of bus phases, 16 ft. on centers. Stations interconnected by 33,000-volt three-phase lead-covered underground cables.



IF PRESENT plans are carried out, the new Calumet Station of the Commonwealth Edison Co., Chicago, in a comparatively short time will be one of the largest generating stations in the country. As originally planned, it was to contain six 30,000-kw. units, aggregating 180,000 kw. for the plant, but already there is talk of eight units and possibly more, if conditions warrant, and there is the possibility that the later units may be of larger capacity. Although not entirely complete, the first section of the plant, consisting of two 30,000-kw. units, has been in operation for the last few months and the work of extending the building for the next two units, which will be of the same size, is already under way.

The plant is just north of One Hundredth Street, on the west side of the Calumet River in the industrial district of South Chicago. It will take the load emanating from the southeastern section of Chicago and vicinity and is tied in with the system through 33,000-volt underground cable lines to Fisk and Quarry Street stations. This necessitates step-up transformers at either end, as the current is generated at 12,000 volts.

To give plenty of room for coal storage and future extension, the site occupies 43 acres. Over 70 per cent of the plan area of the building is devoted to the boiler house and coal-handling equipment, and if heights are considered, the relative volumes show a still larger ratio for the steam-generating end of the plant. These proportions are indicative of the growing importance of the boiler room and of the efforts being made toward higher economy where the possibilities are greatest.

In the station layout full consideration has been given to the convenience and comfort of the operating force. The chief engineer has an exceptionally large

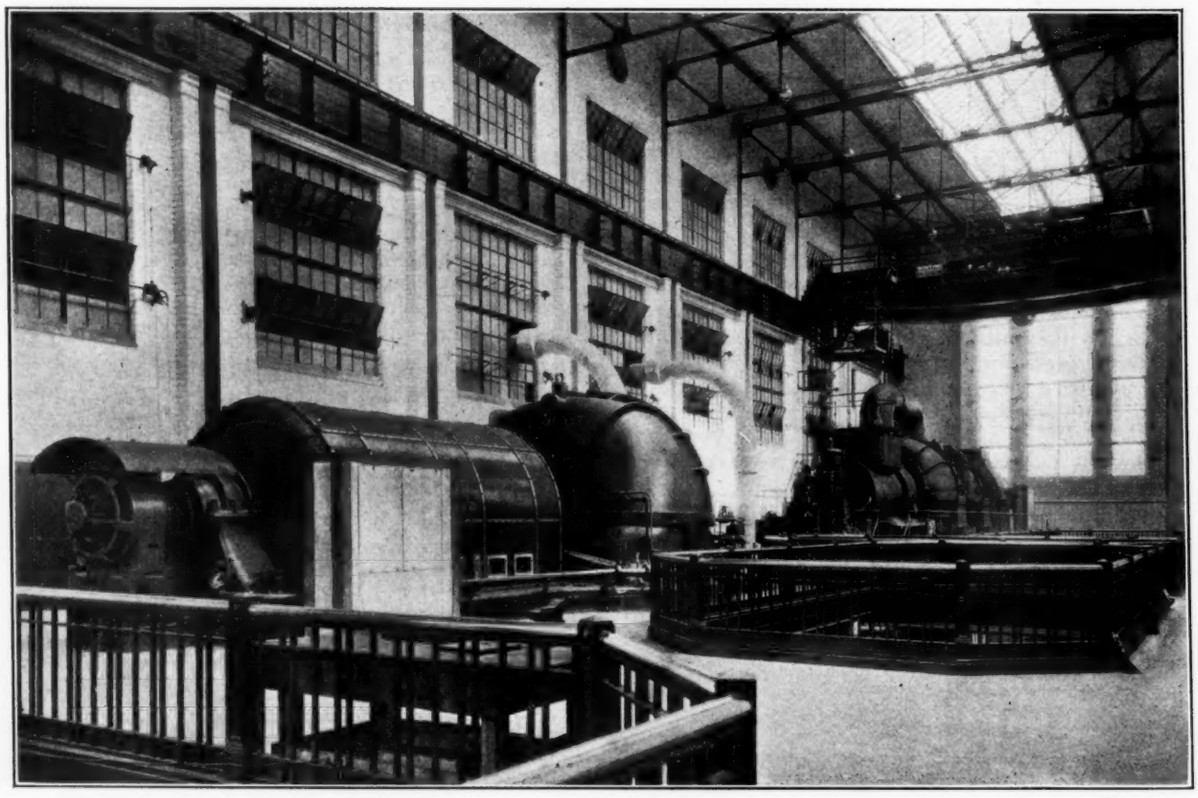


FIG. 1. VIEW OF TURBINE ROOM, SHOWING TWO 30,000-KILOWATT UNITS

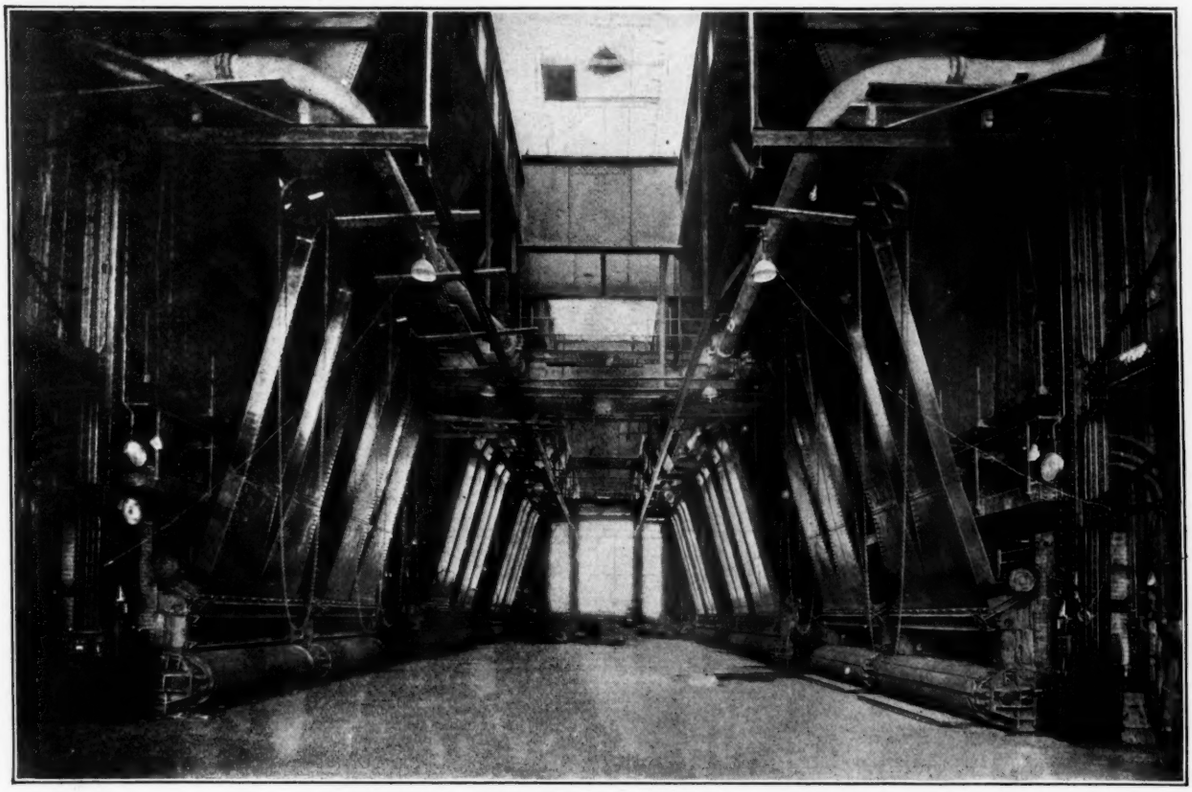


FIG. 2. LOOKING DOWN CENTRAL FIRING AISLE OF BOILER ROOM

and well-appointed office with sleeping quarters in case of emergency calls at night. Adjoining is a large conference room and various offices for the necessary clerical help. A restaurant with full kitchen and refrigerating equipment is being installed. Locker rooms, toilets and shower baths are distributed to best accommodate the various employees. Machine shops for mechanical and electrical repair are provided, and other space is devoted to the storage of supplies and repair parts. Passenger and freight elevators in the boiler house are a decided convenience.

In the mechanical design of the station a number of features have been incorporated which place it a step in advance of the older stations of the company. The boilers are slightly larger and are designed for an operating pressure of 350 lb. gage and 250 deg. superheat, as it is desired to furnish steam at the turbine throttle at a pressure of 300 lb. superheated 200 deg.; or to a final steam temperature of 622 deg. Under present operating conditions the safety valves are set to blow at 330 lb. Forced-draft chain grates are installed to burn Illinois coal. With one exception two stokers per boiler have been provided, and the one exception is a forced-draft chain grate of mammoth proportions. It measures 24 ft. wide and 18 ft. 6 in. long from inside the grate to the rear center. An individual steel economizer is placed directly above each boiler.

The heat balance of the station is maintained by bleeding steam at approximately atmospheric pressure from the main turbines through closed heaters which in conjunction with the open heaters raise the temperature of the feed water to 170 deg. F. The heat from the gland water and in all clean drips is conserved, and other economies are effected, which in the aggregate make it possible to generate a kilowatt-hour at the switchboard on 18,000 to 19,000 B.t.u. The latter figure already has been obtained, and when all covering is on and the plant has settled into routine operation, the lower figure indicates the economy anticipated. Some innovations have been made in the electrical end, an outstanding feature being the wide separation of the bus phases to reduce to a minimum the danger of interphase short-circuits, with switching equipment specially designed to meet the new arrangement. Current limiting reactors are used to exclude outside disturbances.

As may be seen from the sectional elevation of the plant the boilers are set on the second floor. Below the central firing aisle are the train shed for unloading coal and a storage pit having a capacity of 350 tons per boiler. On either side are the stoker ash hoppers from which the ashes are dumped directly into railway cars without any intermediate handling. The forced-draft fans are on the boiler-room floor back of their respective boilers and the induced-draft fans are at either side of the boiler house on a level with the economizers above the boilers. They discharge upward into a smoke flue on top of the roof leading into a self-supporting steel stack located centrally to serve four boilers on the same side of the firing aisle. Both flues and stack are lined, the former by means of the cement gun and the latter with brick. The stacks rise 200 ft. above the boiler-room floor and have an inside diameter of 16 feet.

Four boilers per unit was the original plan, but the seven boilers now installed, have given such excellent

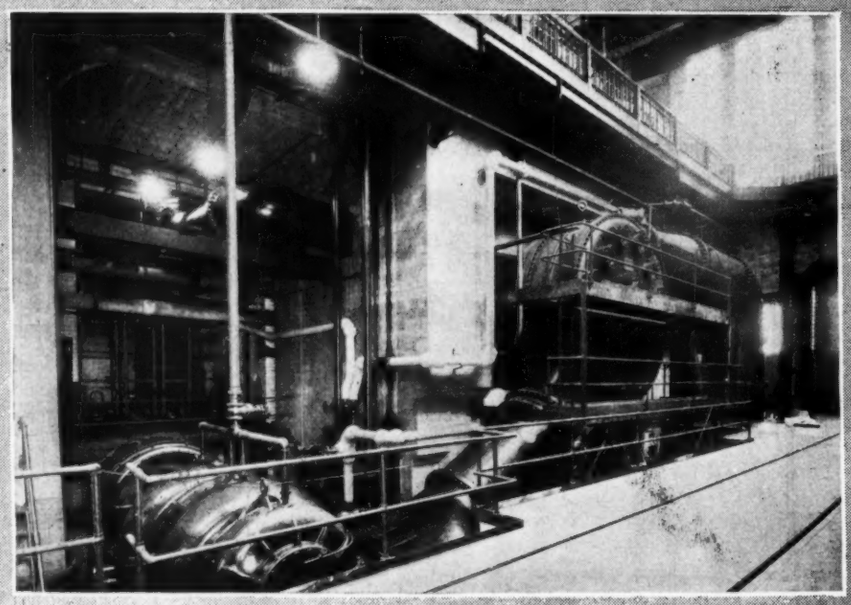


FIG. 3 (LEFT). THE 52,000-SQ.FT. CONDENSER AND CIRCULATING PUMP

The condenser has a normal capacity of 330,000 lb. of steam per hour with cooling water at 45 to 70 degrees and a vacuum 28.5 to 29 inches. Cooling water is supplied by a 55,000 gal. per min. pump. This gives a ratio of 83 lb. of water per pound of steam condensed. Pump driven by 800-hp. slip-ring motors, speed 178 to 295 r.p.m.

FIG. 4 (BELOW). OIL-SWITCH MECHANISM

This mechanism simultaneously operates the contacts in three oil pots of a switch spaced 16 ft. apart.

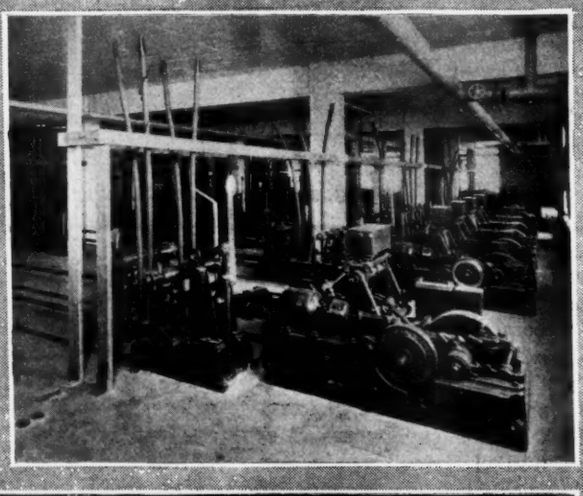
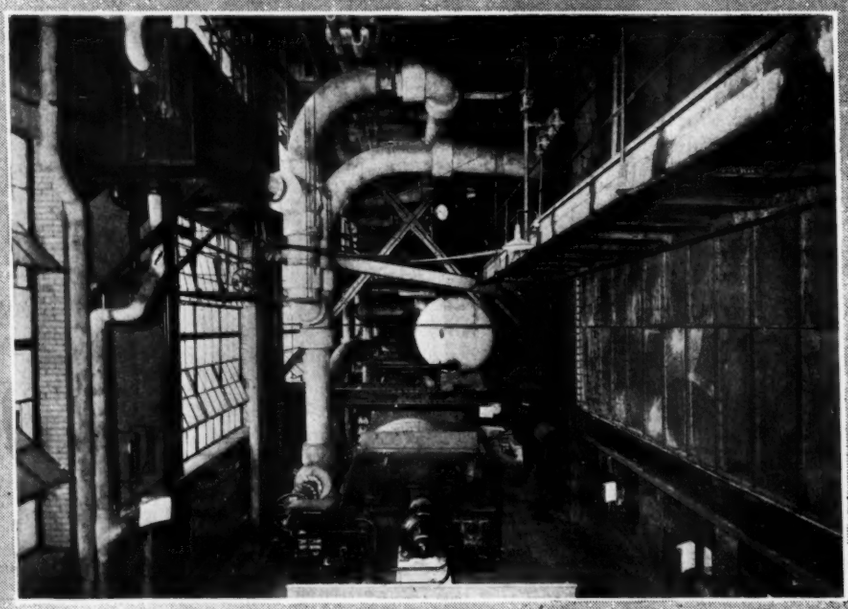


FIG. 5 (ABOVE). TRAIN SHED AND UNLOADING HOPPER

Coal is unloaded by traveling crane to the storage pit or to traveling hopper with feeder and passes through breaker to bucket conveyor.

FIG. 6 (RIGHT). REAR OF BOILERS, SHOWING FORCED-DRAFT FANS

The air to each furnace is supplied by an individual motor-driven multivane fan of 40,000 cubic feet capacity. The motor is equipped with push button remote control from the boiler fronts.



results, operating up to 300 per cent of nominal rating without the least difficulty and delivering 150,000 lb. of steam per hour, that three boilers per generating unit of 30,000 kw. is now considered ample. With a steam rate approximating 10 lb. per kilowatt-hour, it is evident that two of the larger boilers could meet the unit steam requirement. As each boiler contains 15,089 sq.ft. of steam-making surface, the allotment of three boilers per unit provides 45,267 sq.ft. of heating surface to supply steam to a 30,000-kw. generating unit. This is a provision of 1.5 sq.ft. per kilowatt of generator rating. In each boiler there are 4,052 sq.ft. of superheating surface and 9,669 sq.ft. of economizer. The arrangement of the baffling, the dropping of the lower row of boiler tubes, the location of the superheater and the division of the economizer into three sections, with the tubes running crosswise with the boiler tubes, are also clearly shown in the sectional elevation.

Six of the boilers are served by forced-draft chain-grate stokers, two per boiler, set under the low end. Each stoker has an effective area of 182 sq.ft., giving 364 sq.ft. per boiler. To give a wide range of speed the stokers are driven by direct-current motors. Air is supplied by induction-motor-driven multivane fans mounted on the boiler-room floor, and controlled by push buttons on panels at the boiler fronts. The same type of control from the same location is applied to the induced-draft fans. Here also are the instruments in full view of the firemen while making the necessary adjustments of draft pressures and stoker speeds. They consist of steam-flow meters of the indicating and integrating type and others designed to give the steam and air flow. On the latter instruments reliance is placed as a guide to efficient operation. No. CO_2 recorders are installed for permanent use, although upon occasion CO_2 readings are taken by the test engineer of the company. Draft gages indicate the draft over the fire and at the uptake, and a multiple gage with seven tubes gives the draft for each of the six zones of the stoker and the duct pressure. A wattmeter for each unit group of boilers shows the load on the turbo-generator served.

Air Supply to Furnace

Air for combustion may be drawn from the boiler room or from the train shed immediately below, but the turbine-room basement will be the normal source of air supply. From a Y discharge an air duct leads to each side of the stoker windbox. Admission to the air chamber of each zone is effected through sliding dampers controlled by hand levers at the side of the setting, their position determining the volume and pressure of the air for each zone. Cross-connections between the inner ducts make it possible for either fan to supply both stokers of the unit or to equalize the pressure between the two.

A feature of the furnace is the elimination of the bridge wall. The stokers carry back to the rear wall which is provided with inspection doors and I-beam supports to take the weight of the upper portion of the wall should it be necessary to renew the base at the level of the stoker. Water-backs connected into the boiler circulation protect the rear wall, and ventilated tile at the clinker line afford protection to the side and center walls. Flat suspended arches of the new radial-end type are installed. This design was perfected to protect better the steel supports at the heel of the arch where protection is most needed, particularly with forced-draft stokers operating at high rates of combustion.

With the bottom of the front tube header 15 ft. 4 in. above the floor and the boiler tubes at the entrance to the first pass approximately 20 ft. above the grates, a furnace volume of 6,700 cu.ft. is secured. This is a provision of 18.4 cu.ft. of furnace volume per square foot of grate area, or roughly 0.3 cu.ft. per pound of coal burned at a combustion rate of 60 lb. of coal per hour per square foot of grate surface.

Illinois coal of 10,000 B.t.u. is burned. For the 300 per cent rating the practice is to carry a 7- to 8-in. fire and air pressures of 0.7 in. in the first zone, 0.8 in. in the second, 0.7 in. in the third and for the balance of the stoker a graduated reduction down to 0.2 in. for the sixth zone. The air pressures are varied to suit the load, but for the different zones they stand in the same relative proportions.

Features of Large Stoker

Under the seventh boiler the installation of the larger stoker is under way. As previously stated it is 24 ft. wide and 18 ft. 6 in. long with an effective area of 444 sq.ft., as compared to 364 sq.ft., the aggregate area of the two stokers serving the other units. The stoker is exceptionally heavy, so that it is built permanently in place. Although the grate surface is continuous, the stoker is made up of two separate chains, with the driving shafts coupled at the center and a driving motor at either side, the two being under common control. Approximately 7 per cent air space has been provided and to insure uniformity, the sides of the links have been planed. To prevent clinker adherence, water boxes 7¼ in. square, are placed on the ledge plates at the sides of the furnace and a 10-in. water back protects the rear wall. All three are connected into the boiler circulation. The rear of the stoker is set 4 in. higher than the front to give sufficient pitch to the side boxes to insure circulation and prevent the formation of steam pockets. The stoker has six zones and air is supplied by two motor-driven fans of the type and capacity employed for the other units.

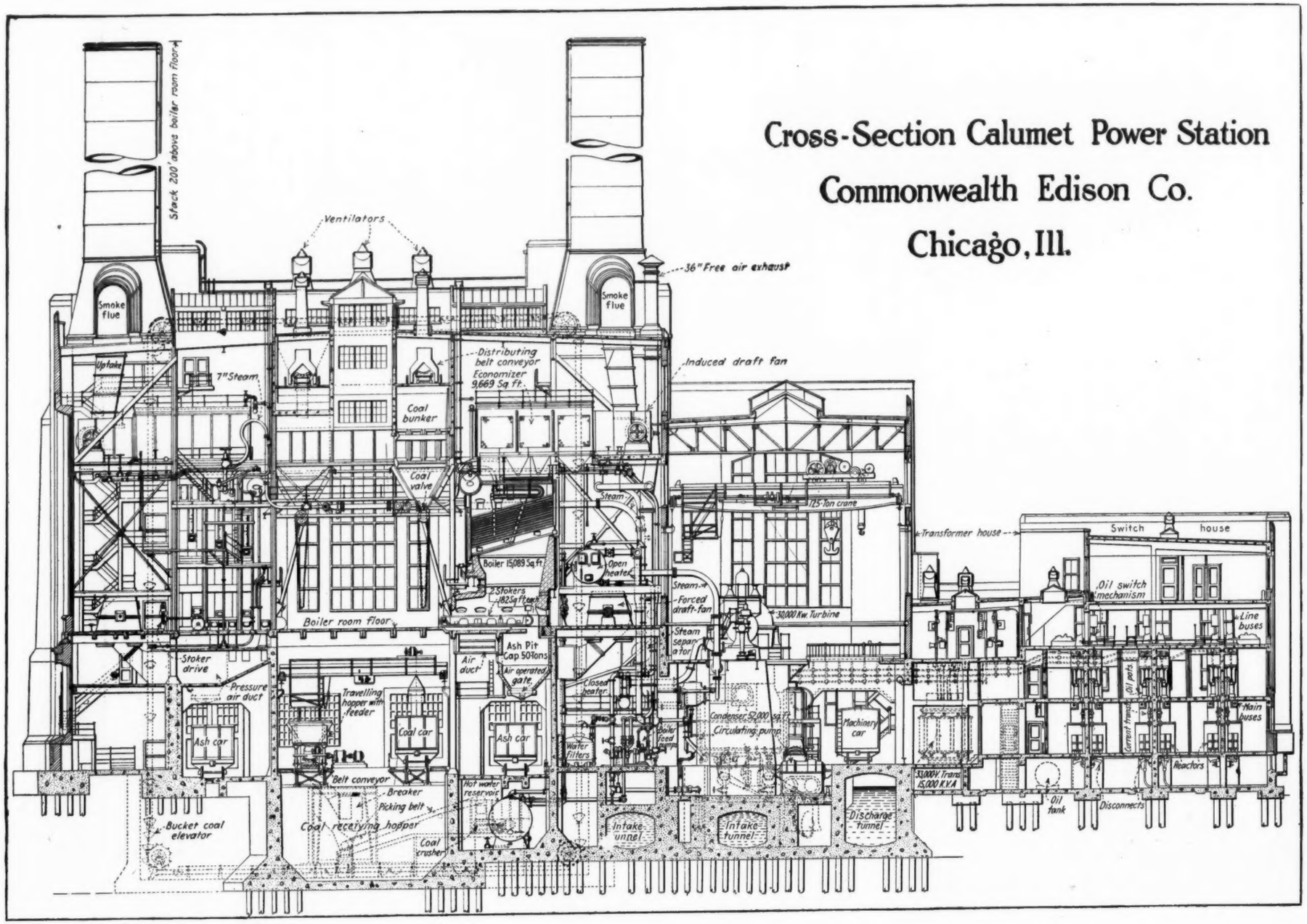
Fig. 8 is a detail view showing the general construction and the method of supporting the arch. An interesting feature is the provision of a radial or "fan" ignition arch extending 23 in. into the furnace and allowing a gate opening of 20 in. The main arch, which is 7 ft. long, also has the radial or "fan"-end construction employed in the other units.

To cut down the size of the steel supporting members that would be necessary for a span of 24 ft., a 15-in. I-beam was suspended at the center from the two 24-in. I-beams used to support the boiler front. The suspended beam runs lengthwise of the arch, and the supporting members extending across the furnace are framed into it with their opposite ends resting on the side walls.

Ash-Disposal System

Ashes are discharged from the rear end of the stokers into 50-ton hoppers placed directly underneath. These hoppers are protected against the action of the hot ashes and are provided with a sprinkler system for wetting down before they are discharged through pneumatically operated gates into railway cars. With no intermediate handling, the ash problem has been simplified.

Cross-Section Calumet Power Station
Commonwealth Edison Co.
Chicago, Ill.



The hoppers have been segregated from the rest of the plant, and this applies also to the coal-handling system, so that there should be no coal or ash dust

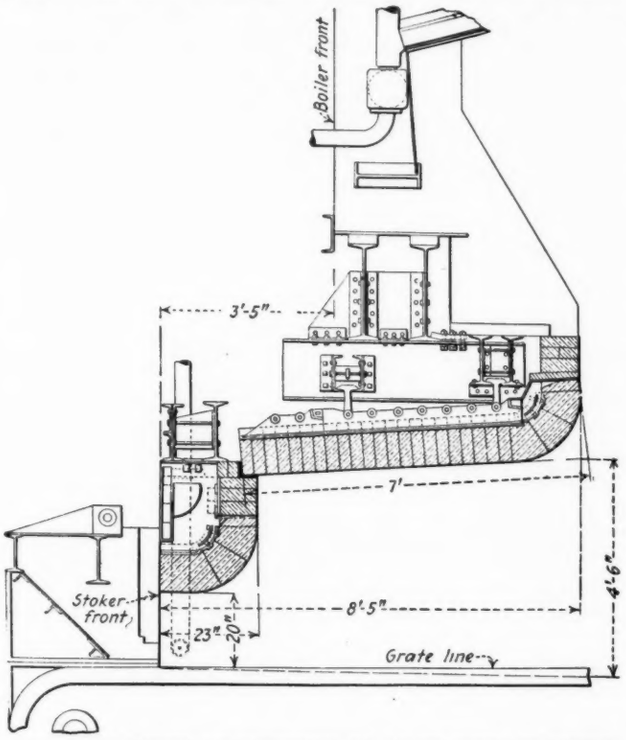


FIG. 8. METHOD OF SUSPENDING ARCH OVER STOKERS

to interfere with the operation of the equipment or to detract from the appearance of the plant.

All high-pressure piping is of steel, double-extra-heavy, with steel fittings and welded joints. Two 7-in. leads, one from either side of each boiler, unite through a special Y fitting into a single line leading to the main steam header for the unit, which is 18 in. in diameter. There is interconnection between these main headers, and the header valves, which necessarily are of large size, are steam-operated.

Coal is unloaded in the train shed immediately under the central firing aisle of the boiler room. The cars are brought in at approximately grade level, 32 ft. below the boiler-room floor, and by means of a traveling crane are unloaded either into a large storage pit or to a traveling hopper with a feeder, located at the side of the train shed opposite to that occupied by the unloading track.

From the hopper the coal is fed onto a belt conveyor having an ultimate capacity of 400 tons per hour. The delivery is through a Bradford breaker serving the present installation. With the next addition to the plant another breaker will be installed and the belt will then deliver to each unit at the rate of 200 tons an hour. Although this type of breaker is used extensively in the byproduct coke industry, this is the first installation of the kind for a central station.

The breaker, which supplants the usual roll crusher, is nothing more than a large steel cylinder 12 ft. in diameter and 17 ft. long, with a large number of 1½-in. holes in the shell of the cylinder. The coal is fed inside the cylinder at one end and is carried up as the cylinder slowly revolves until it reaches the top, when, in dropping to the bottom of the cylinder, it is broken up and discharged through the holes in the shell. The tramp iron, sulphur balls, mine props and any other refuse that may be in the coal are held back and passed out at the end of the breaker onto a belt conveyor. Here the refuse material is picked off and any good coal that may have been carried out of the breaker with it is allowed to pass on to another conveyor delivering into a small two-roll crusher which discharges into the pivoted bucket conveyor carrying the coal to the top of the boiler house.

Distributing the Coal

Coal from the breaker passes into collecting hoppers and is fed onto a short belt conveyor which is reversible and may feed either one of two pivoted bucket conveyors elevating the coal to the overhead bunker level. Only one of these pivoted bucket conveyors has been installed, but when the new addition to the plant is made the other will be added.

From the pivoted bucket conveyor the coal is passed into either one of two receiving hoppers which discharge directly onto belt conveyors running longitudinally above the coal bunkers. One set of reinforced-concrete bunkers, with individual capacities of 250 tons, serves each row of boilers. Each of the elements of the conveying system is motor-driven through inclosed-gear speed reducers. From the bunkers uniform distribution of coal across the stokers is assured by means of sheet-steel spouts provided with baffle plates. The bunker gate is controlled from the boiler-room floor.

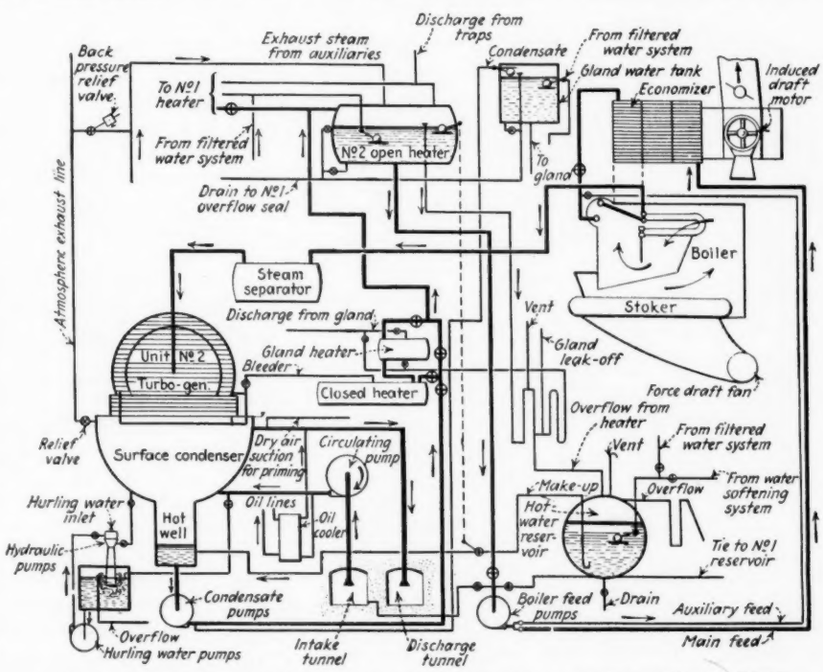


FIG. 9. DIAGRAMMATIC LAYOUT OF UNIT NO. 2 WITH AUXILIARIES

Over the central portion of the firing aisle it will be seen that there is considerable space between the bunkers. With a monitor skylight above and large

glass areas in the end walls, the boiler room has plenty of daylight and good ventilation.

In the coal yard there will be an ultimate storage capacity for 150,000 tons of coal. Here tracks will be provided with a steam locomotive to handle the cars and a locomotive crane to transfer the coal to and from storage.

One of the features of the station is the arrangement of the feed-water system and the method of maintaining the heat balance. Temperature of the feed water the temperature of the water in the open heater at all times and guides the operator in varying the amount of steam bled from the turbines by adjusting a hand-operated valve in the bleeder line.

To heat the condensate, a certain amount of exhaust steam from auxiliaries as well as the discharge from steam traps is available. Three of the four boiler-feed pumps are turbine-driven. There is also a 50-hp. turbine-driven service pump, and with the exception of the circulating pumps the condenser auxiliaries are

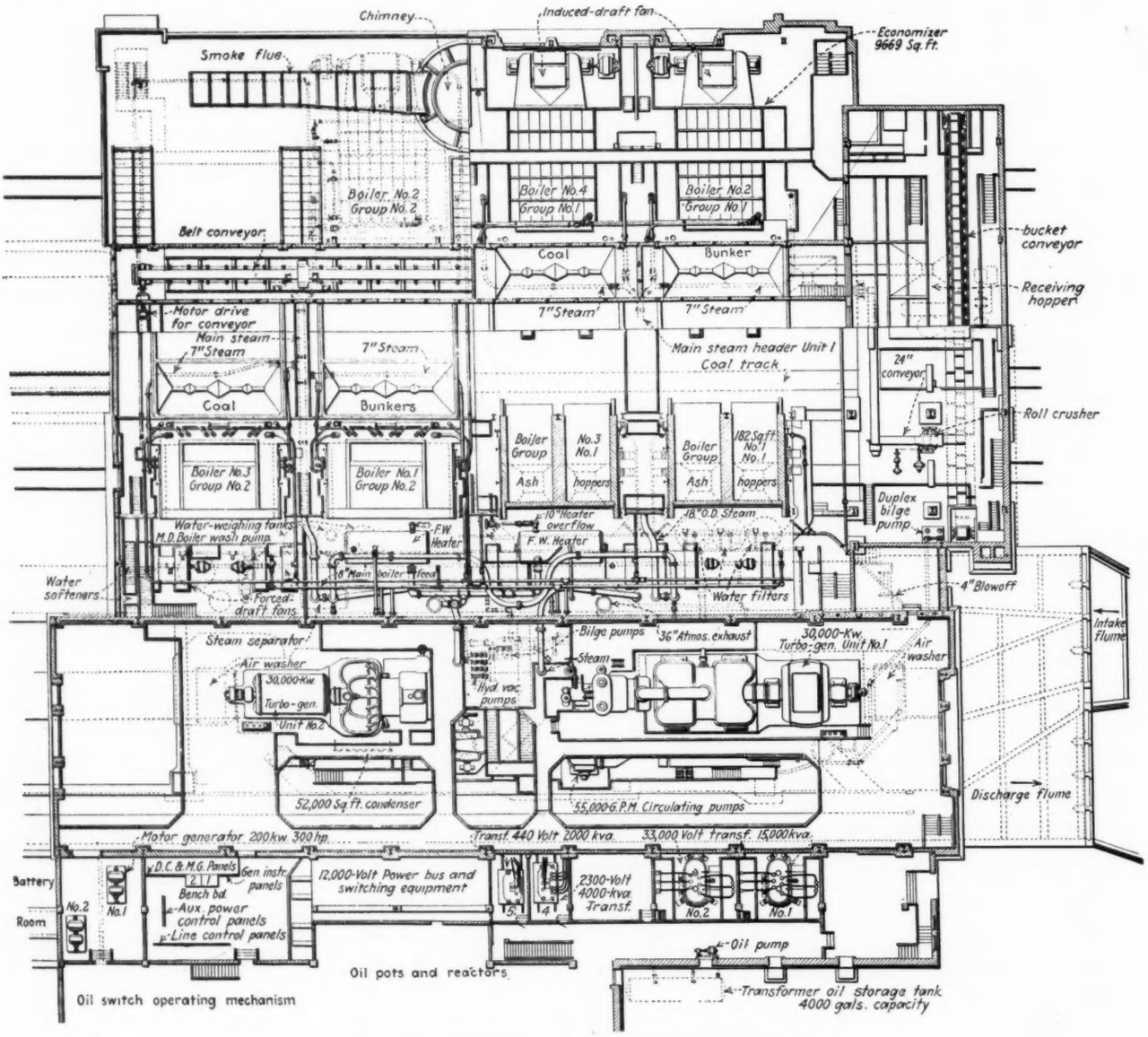


FIG. 10. GENERAL PLAN OF COMPLETE PLANT

will be maintained at about 175 deg. F. to prevent condensation of the sulphurous acid in the flue gases and thus eliminate to a great extent the external corrosion that would otherwise take place in the steel economizers. Essentially, this is accomplished by introducing a closed heater between the condenser hotwell and the usual open feed-water heater. From the main turbines at about atmospheric pressure, sufficient steam is bled through the closed heater to maintain the water in the open heater at the temperature previously given. A recording thermometer in the boiler room shows in duplicate, one set being driven by turbines and the other by motors. As many of the auxiliaries as the heat balance will permit will be electrically operated.

An open heater rated to heat 400,000 lb. of water per hour from 85 to 175 deg. F. is provided for each unit, the two being connected in parallel. The closed heaters are practically of the same capacity. The arrangement of the piping and auxiliaries for both units are practically identical with the exception of the gland heater and the hydraulic air pumps. The use of steam seals in turbine No. 1 made it desirable

to recover the heat in this steam by passing it through an additional closed heater. The condensation from both of these closed heaters is returned to the hotwell of the condenser. The condensate pump draws from the hotwell of the condenser and forces the feed water through the closed heaters to the open feed-water heater. It then passes down to the feed pumps, which are cross-connected on the discharge side to give flexibility, and is forced up through the economizers to the boilers against a head ranging from 380 to 400 lb. gage. Another path is through the auxiliary feed or wash line which bypasses the economizers and leads directly to the boilers. Feed-water regulators control the supply entering each boiler.

Makeup water is carried in a hot-water reservoir which receives the overflow from the open heater and the gland leakage. To maintain the level in this reservoir, water softened by the Permutit system may be admitted under float control. As the makeup should not exceed 5 per cent, the rated capacity of this system is 4,000 gallons per hour. An additional source of supply is the filtered-water system installed principally for gland cooling.

From this reservoir the makeup water is introduced into the hotwell of the condenser. As the level drops in the open heater, a float opens a valve in the line from reservoir to condenser hotwell and the vacuum draws over a supply of makeup water. If the level in the open heater should continue to fall, a second float at a lower level admits filtered water directly to the open heater.

The supply of gland water is maintained in an open tank elevated on the boiler-room wall to give the necessary head. The primary supply is condensate from the condenser hotwell, which is admitted under float control. In case of necessity, however, a second float lower down in the tank opens a connection to the filtered-water system. The latter consists of three pressure filters each rated to pass 150 gal. per min., the original supply being condenser circulating water.

Generating Units and Condensers

As previously stated, two generating units have been installed, each having a capacity of 30,000 kw. at 85 per cent power factor. Unit No. 1 is a tandem compound machine having a speed of 1,200 r.p.m., and unit No. 2 develops the entire capacity in a single casing, the speed being 1,800 r.p.m. The condensers are of the surface type with 52,000 sq.ft. of surface, which reduces to 1.73 sq.ft. per kilowatt of generator rating. With a cooling-water temperature ranging from 45 to 70 deg. and the vacuum from 28.5 to 29 in., each condenser has capacity to condense 330,000 lb. of steam per hour. The circulating-pump capacity is 55,000 gal. per min., giving a maximum ratio of 83 lb. of cooling water to 1 lb. of steam condensed. For each unit one circulating pump of the slow-speed type is installed. The drive is an 800-hp. slip-ring induction motor of which the speed may be varied from 178 to 295 r.p.m. to meet the variation in load or in the temperature of the cooling water. The total head on the pump, including a suction lift of 6 ft., is approximately 22 ft. The other condenser auxiliaries are installed in duplicate, one unit of the pair being turbine-driven and the other motor-driven.

Unit No. 1 has two condensate pumps each rated at 1,000 gal. per min., with 100-hp. 2,300-volt induction-motor drive in one case and a 60-hp. turbine in the other. The air pumps are of the Leblanc type.

For Unit No. 2 hydraulic air pumps are employed. Four pumps are installed, although normally two will take care of the requirements. The installation includes hurling-water pumps and a tank to store the supply of water circulated through the air nozzles. In the tank the air is separated from the water and allowed to escape, and provision is made to admit makeup as needed. The hurling-water pumps are mounted on the same shafts as the condensate pumps and the two units have 150-hp. turbine or motor drives.

Circulating-Water Tunnels and Screens

Circulating water for the condensers is taken through a cribhouse located on the bank of the Calumet River. Here there are installed for the present two units, four revolving screens. They are backed up by a double set of stationary screens which will be replaced ultimately by traveling screens. From the cribhouse to the intake tunnels under the turbine-room basement the water is carried in an open flume. Two tunnels have been provided, one for the first three units and the second for later additions to the station. A common discharge tunnel carries the water to another open flume leading back to the river. Owing to the fact that at times the flow of the river reverses, a retaining wall has been set up in the river, making a channel that extends both ways from the cribhouse, and in the concrete construction numerous gates have been provided, so that the intake will always be from upstream and the water discharged downstream.

In providing cooling air for the generators, a closed system has been employed; that is, the cooling air is recirculated, being cooled by passing through a water spray. In other words the hot air from the generator is returned to the machine after cooling. The cooling and humidifying water is taken from the circulating-water tunnel and the overflow allowed to run to waste. There is an alternate provision for carrying the hot air from the generators into the boiler room and drawing in fresh air through the air washer. In this event the water may be recirculated, a large settling chamber being provided under the apparatus to receive the water and maintain a sufficient supply for the circulating pump. A float in this settling tank or basin automatically adds makeup water as required.

Oil Storage and Lubrication

Oil strainers are installed at the main units, but no oil filters are employed. In the base of each unit sufficient storage has been provided for 1,000 gal. of oil. This oil is pumped to the bearings and returned to storage in the usual way. To keep it at the proper temperature, the storage supply is constantly circulated through a heat exchanger or oil cooler of the tubular closed type. The cooling medium is condenser circulating water. The cooler is connected across the inlet and discharge, and the drop through the condenser gives the head necessary to circulate the water through the cooler.

At the end of a week the oil in the turbine base is replaced. The dirty oil is pumped into a 2,000-gal. tank. The entire supply is run through a De Laval separator to remove the moisture and the dirt, and is discharged to a clean oil tank of the same capacity. At the next renewal this oil is pumped back into the turbine storage.

DATA ON PRINCIPAL MECHANICAL EQUIPMENT IN CALUMET STATION OF COMMONWEALTH EDISON COMPANY

GENERAL

Location of plant	South Chicago
Character of service	Light and power
Capacity present, two 30,000-kw. units, kw.	60,000
Boilers installed (15,089 sq.ft. each)	7
Turbine room, ft.	55 x 213
Transformer house, ft.	17 x 206
Switchhouse, ft.	57 x 137
Boiler room, ft.	145 x 217
Distance from condenser floor to turbine platform, ft.	31
Distance from ash track to boiler-room floor, ft.	34
Width of firing aisle	35

BOILERS AND SUPERHEATERS

Manufacturer	Babcock & Wilcox Co.
Type	Cross-drum Water-tube
Number installed	7
Steam making surface per boiler, sq.ft.	15,089
Steam making surface per kw. installed, sq.ft.	1.76 to 1
Grate area per boiler, sq.ft.	364 and 444
Ratio steam making surface to grate area	41 and 34 to 1
Furnace volume, cu.ft.	6,700
Ratio furnace volume to steam-making surface	1 to 2.25
Ratio furnace volume to grate area	18.4 and 15 to 1
Size of tubes, in.	4
Boiler operating pressure, lb. gage	325
Type of superheater	Integral
Manufacturer	Babcock & Wilcox Co.
Location of superheater	Between first and second pass
Superheating surface, sq.ft.	4,052
Ratio superheating to steam-making surface	0.27
Superheat, deg. F.	200
Total steam temperature, deg. F.	630

COAL

Kind of fuel	Illinois Bituminous
Heat value, B.t.u. per lb.	10,000
Proximate analysis: Volatile 34 per cent; fixed carbon, 36; ash, 15; moisture, 14; sulphur, separate, 5 per cent.	

STOKERS

Manufacturer	Combustion Engr. Corp.
Type	Forced-draft chain grate
Number of stokers	12
Number of air zones per stoker	6
Grate area per stoker, sq.ft.	182
Grate area per boiler, sq.ft.	364
Ratio grate area to steam-making surface	1 to 41
Rate of combustion, lb. per hr. per sq.ft. of grate area	60
Drive, direct-current motor	2
Arches, radial end	Liptak Fire-Brick Arch Co.
Manufacturer	Babcock & Wilcox Co.
Type	Forced-draft chain grate
Number of stokers	1
Number of air zones per boiler	6
Grate area per boiler, sq.ft.	444
Ratio grate area to steam-making surface	1 to 34
Rate of combustion, lb. per hr. per sq.ft. of grate area	60
Drive, direct-current motors	2
Arch, radial end	M. H. Detrick Co.

ECONOMIZERS

Manufacturer	Babcock & Wilcox Co.
Type	Steel tubes and steel headers
Location	Directly over boilers
Heating surface, sq.ft.	9,669
Ratio economizer surface to steam-making surface	1 to 1.56

INDUCED DRAFT EQUIPMENT

Manufacturer	B. F. Sturtevant Co.
Number of fans	2
Type	Squirrel-cage
Capacity, cu.ft. per min.	153,000
Drive	200 hp. 2,300-volt Westinghouse motor

FORCED-DRAFT EQUIPMENT

Manufacturer	B. F. Sturtevant Co.
Number of fans	7
Type	Multivane
Capacity, cu.ft. per min.	40,000 to 60,000
Drive	50 hp. 440-volt Westinghouse Induction motor

CHIMNEYS

Type	Self-supporting steel
Stack lining	American Chimney Construction Co.
Number of boilers per stack	4
Height above grate, ft.	200
Diameter at top, inside, ft.	16
How supported	Superimposed on building steel structure

COAL HANDLING

Traveling hopper with feeder, 10x13 ft.	Robins Conveying Belt Co.
Drive	10-hp. 440-volt motor, Jones inclosed-gear speed reducer
One belt conveyor, 36 in. 192 ft. 8 in. centers	Robins Conveying Belt Co.
Capacity at 395 ft. per min., tons per hour	400
Drive	30-hp. 440-volt motor, Jones inclosed-gear speed reducer
One belt conveyor, 36 in. 11 ft. 6 in. long	Robins Conveying Belt Co.
Capacity at 190 ft. per min., tons per hour	200
Drive	5-hp. 440-volt motor, Jones inclosed-gear speed reducer
One belt conveyor, 24 in., 33 ft. long	Robins Conveying Belt Co.
Drive	5-hp. 440-volt motor, Jones inclosed-gear speed reducer
One belt conveyor, 24 in., 11 ft. long	Robins Conveying Belt Co.
Drive	5-hp. 440-volt motor, Jones inclosed-gear speed reducer
Two belt conveyors, 30 in. 118 ft. long	Robins Conveying Belt Co.
Capacity at 329 ft. per min., tons per hour	200
Drive	30-hp. 440-volt motor, Jones inclosed-gear speed reducer
One pivoted bucket conveyor	Mead Morrison Mfg. Co.
Capacity, tons per hour	200
Drive	50-hp. 440-volt motor
One Bradford breaker	Pennsylvania Crusher Co.
Size	12 ft. diam., 17 ft. long
Capacity, tons per hour	200
Drive	100-hp. 440-volt belted motor
One crusher, 20 x 30 in., two-roll	Robins Conveying Belt Co.
Drive	20-hp. 440-volt induction motor
One crane, electric bridge, 4 motor	Whiting Corp.
Span, ft.-in.	38-
Capacity, 2 cu.yd. bucket, tons per hour	175
One locomotive crane, 2 cu.-yd. bucket	McMyler Intertstate Co.
Storage capacity under train shed, tons per boiler	350
Storage capacity, yard, tons	150,000
Bunkers (kind and size)	Concrete, 250 tons per boiler
Method of reclaiming from yard storage	Locomotive crane
Coal weighing	Track scale

PRIME MOVERS

	Unit No. 1	Unit No. 2
Manufacturer	Westghse Elec. & Mfg. Co.	General Electric Co.
Type	Tandem compound	17-stage Curtis
Capacity, 85 per cent power factor, kw.	30,000	30,000
Speed, r.p.m.	1,200	1,800
Pres. at throttle, lb. gage	300	300
Superheat, deg. F.	200	200
Type of generator	Three-phase, 60-cycle, 12,000-volts	
Ventilating air, cu.ft.	110,000	80,000
Size exciters, d. c. kw.	140	140
Emergency excitation:		
Two 200-kw. motor generators	Westinghouse Elec. & Mfg. Co.	
One 120-cell storage battery	Electric Storage Battery Co.	
System lubrication	Weekly renewal, continuous cooling, purification —by DeLaval separator	

CONDENSERS

Type	Surface	Surface
Make	Westghse Elec. & Mfg. Co.	Worthington Pump & Mch. Co.
Tube surface, sq.ft.	52,000	52,000
Square feet of surface per kw. of generator-rating.	1.73	1.73
Circulating pump, type	Two-Impeller	Single-Impeller
Capacity, gal. per min.	55,000	55,000
Lb. water per lb. steam condensed	83	83
Drive, slip-ring motor, hp.	800	800
Condensate pumps, number	2	2
Capacity each, gal. per min.	1,000	1,000
Hurling-water pumps on same shaft as condensate pumps		2
Drive	60-hp. turbine 100-hp. motor	150-hp. turbine 150-hp. motor
Air pumps, Leblanc type	2	
Drive	100-hp. turbine, 150-hp. motor	
Air pumps, hydraulic		4
Type of screens		Traveling
Number		4
Manufacturer		Link Belt Co.
Drive motors, hp.		5
Pumps to wash screens, two, 110-hp. motors	Worthington Pump & Mach. Co.	

MISCELLANEOUS EQUIPMENT

No.	Equipment	Type	Size	Manufacturer
2	Feed-water heaters	Open	400,000 lb. per hr.	Warren Webster & Co.
2	Feed-water heaters	Closed	400,000 lb. per hr.	Patterson-Kelley Co.
1	Feed-water heater (gland)	Closed	350,000 lb. per hr.	Patterson-K lley Co.
3	Boiler-feed pumps	4-stage Jeanesville 389-hp. turbine	900 g.p.m.	Worthington Pump & Mach. Co.
1	Boiler-feed pump	4-stage Jeanesville 400-hp. motor	900 g.p.m.	Worthington Pump & Mach. Co.
1	Boiler wash pump	4-stage Jeanesville 200-hp. motor	500 g.p.m.	Worthington Pump & Mach. Co.
2	Service pumps	Volute 50-hp. turbine 75-hp. motor	1,000 g.p.m.	Worthington Pump & Mach. Co.
2	Air conditioning	Water sprays	110,000 cu.ft. per min. 80,000 cu.ft. per min.	Carrier Air Conditioning Co.
3	Cooling-water pumps	Volute 40-hp. 30-hp. motor	One 750 g.p.m. Two 650 g.p.m.	Buffalo Steam Pump Co.
7	Soot blowers	Diamond	16 units	Diamond Power Specialty Corp.
3	Water filters	Pressure	150 g.p.m.	New York Continental Jewell Filtration Co.
1	Air compressor	Compound 150-hp. motor	625 cu.ft. per min. 125-ton	Sullivan Mchry. Co. Whiting Corp.
1	Station Crane	Elec. bridge		
1	Water-softening system	Permutit	4,000 g.p.m.	Permutit Co.

VALVES, METERS, PIPING, ETC.

Equipment	Manufacturer
Feed-water regulators	"S-C" Regulator Manufacturing Co.
Safety valves	Consolidated Safety Valve Co.
Blow-off valves	Edward Valve & Manufacturing Co.
Sil-O-Cel blocks	Celite Products Co.
Boiler-stop and check valves	Edward Valve & Manufacturing Co.
High-pressure steam gate valves	Crane Co.
Sargol welded joints	Edward Valve & Manufacturing Co.
High-pressure water globe valves	Edward Valve & Manufacturing Co.
Steam pipe, fittings and steam traps	Crane Co.
Pipe covering	Johns-Manville Inc.
Steam-flow meters	Republic Flow Meters Co.
Steam-flow meters	Bailey Meter Co.
Recording and indicating gages	Ashton Valve Co.
Recording thermometers	Taylor Instrument Co.
Master steam gage	Ashton Valve Co.
Draft gages	Lewis M. Ellison

As shown in the sectional elevation, the transformer house is adjacent to the turbine room and beyond is the switchhouse with four floors, the first being occupied by the reactors, the second by the oil switches, the third by the switch-operating mechanism and the fourth by offices, the restaurant and rooms devoted to other purposes.

It is the plan to operate the station in two sections, the buses being connected together through two sets of 1,000-ampere, 1-ohm reactors in series, with a 2,000-ampere bus tie switch between the reactors.

As much of the auxiliary apparatus in the station is motor-driven, elaborate provision has been made to insure the continuity of the electric supply. All auxiliary motors larger than 100 hp. are on 2,300-volt service and those below 100 hp. are designed for 440 volts, with the exception of the stoker motors, which are 220-volt direct-current machines. To supply these services step-down transformers are connected to a special 12,000-volt bus placed in the transformer house.

For the 2,300-volt auxiliary service three buses have been provided—a 1,200-volt starting bus, a 2,300-volt running bus and a transfer bus, the last being an alternate to the running bus and supplied by an emergency transformer from the opposing section of the main auxiliary bus. The 2,300-volt auxiliary power center is located in the transformer house at the turbine-room floor level. All service switches for the large motors are installed in this location and arranged for remote control from the motors. Compensating starters are employed only on the 440-volt motors. When the starting push button at the motor is closed, the motor is connected to the 1,200-volt starting bus fed from half taps on the transformer through a starting switch which remains closed until the starting current has dropped to a predetermined value, at which time an accelerating relay operates and opens this switch. Auxiliary contacts on the starting switch complete the closing circuit on the running switch after the starting switch is open, thus automatically throwing the motor over from the starting bus to the 2,300-volt running bus. The closing of the stop button at the motor opens the running switch when it is necessary to stop the motor, and at the same time the resistance in the control equipment of a variable-speed motor is automatically cut in to the rotor circuit, so that the motor is in condition for normal starting.

Throughout the station 220-volt direct-current control is employed. The operating bus is supplied by either one of two 200-kw. motor-generator sets, with a 120-cell, 1,500-ampere-hour storage battery floating on the line. From this same bus the stoker motors are driven and it is also an emergency source for excitation of the main generating units.

A special feature of the station is the use of 33,000-volt underground cable connections to Fisk Street station. Up to date this is the highest voltage being used for transmission in a three-phase cable. There are two of these ties lines consisting of three-conductor, 350,000 circ. mil. lead-covered cables, each having a capacity of 15,000 kva. The lines are fed through two 15,000-kva., 12,000 to 33,000-volt transformers.

The design and construction of the steam plant was carried on under the general direction of Sargeant & Lundy, consulting engineers, while the electrical installation was designed and installed by the engineering department of the operating company.

The Real Mean Effective Pressure

By W. H. Wakeman

When we wish to indicate a steam engine, the indicator is connected to one end of the cylinder and a diagram along the lines of Fig. 1 is obtained. The line *ABC* represents the steam pressure acting on the piston during the working stroke; the line *DEA* represents the back pressure that the piston must overcome on the

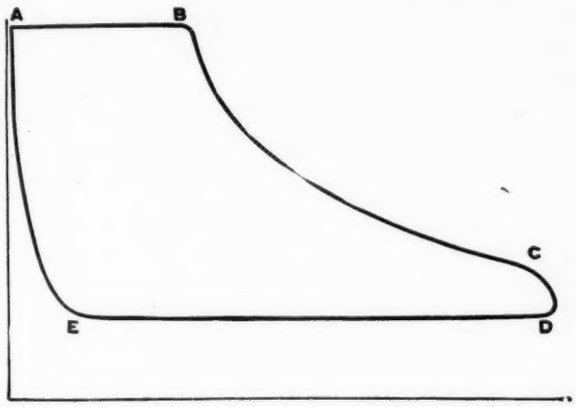


FIG. 1. INDICATOR DIAGRAM

return stroke. The area of diagram represents to some scale the work done in one end of the cylinder by the piston during the forward power and return exhaust stroke. The mean effective pressure in this end of the cylinder is the average height of the area and is equal to the area divided by the length.

If the indicator be connected in turn to both ends of the cylinder, two diagrams, Fig. 2, are secured. It is apparent that if the areas of the two diagrams are equal, the mean effective pressures are the same. But even though the areas be equal and the mean effective pressures are equal, it does not necessarily follow that

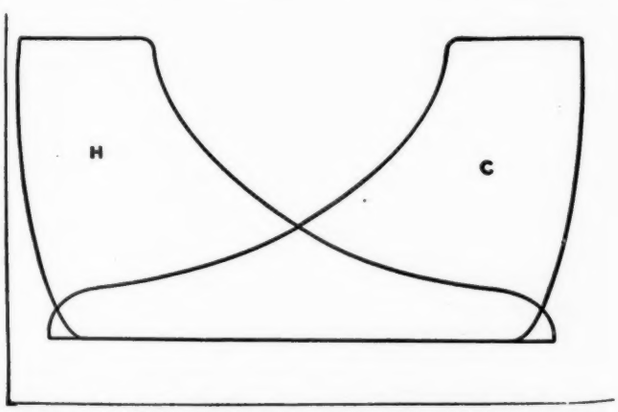


FIG. 2. DIAGRAM FROM BOTH ENDS OF CYLINDER

the average net pressure against the piston during the forward, or head end stroke is the same as the average net pressure on the piston during the return or crank end stroke. Also, even though the diagram areas be unequal, it is possible for the net pressure on the piston to be the same for both strokes. To some readers this seems absurd, but do not judge too hastily. Investigate impartially.

When we take a single diagram, which is assumed to be nearly perfect, the straight horizontal line at the top shows the continued admission of steam, and as this line begins to fall into a graceful curve, it indicates the expansion of the steam. What is taking place on the opposite side of the piston during this stroke? We do not know, and the completion of the diagram does not inform us on this point, because the counter-pressure and compression lines indicate the pressure on the same side of the piston on the return stroke. When we proceed to take a diagram from the opposite end of the cylinder, the counter-pressure line shows the pressure opposing the advance of the piston, while the steam and expansion lines of the head end were being taken.

Fig. 3 is a pair of diagrams taken from an engine in actual service. The planimeter showed that the mean effective pressure on the head end was 22 lb. and on the crank end 40 lb. The average mean effective pressure on both ends is $22 + 40 \div 2 = 31$ lb. This result was proved as follows, all pressures taken above the atmospheric line for convenience. For the head end the average forward pressure is 38 lb. and the average back pressure is 16 lb. Then $38 - 16 = 22$ lb. For the crank end these items are 47 and 7, respectively, hence $47 - 7 = 40$ lb. This gives the apparent mean effective pressure and is correct for all practical purposes when calculating the indicated horsepower, etc.

It is not, however, the actual mean effective pressure acting on the piston of this engine during the two strokes.

Fig. 4 is a diagram that was derived as follows: The upper full lines are from the head end of Fig. 3, and the lower dotted lines follow the back-pressure line of

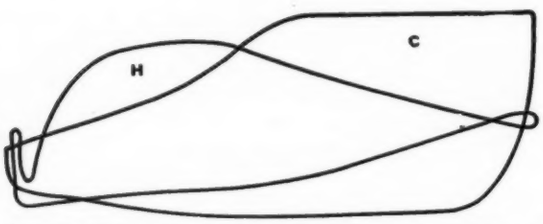


FIG. 3. ACTUAL DIAGRAMS FROM ENGINE

FIG. 4. CORRECTED DIAGRAM FOR HEAD END

the crank end. The forward pressure is 38 lb., as stated, and the back pressure is 7 lb.; therefore the mean effective pressure is $38 - 7 = 31$ pounds.

In Fig. 5 the upper lines are from the crank end of Fig. 3, while the lower dotted lines show the back pressure in the head end of the same illustration. The forward pressure is 47 lb. with a back pressure of 16 lb. in the head end, making a mean effective pressure of $47 - 16 = 31$ lb. The dotted part of the back-pressure line rising above the steam line in Fig. 4 is caused by the compression in the crank end. The resulting loop gives a negative area, indicating that part of the work of compression is lost.

It is not often that a pair of diagrams can be secured that so fully illustrate the point that it is desired to present, but these figures are submitted just as I secured them in practice without manipulation to show a desired result.

Having used these diagrams to illustrate a feature, the following additional data are presented. The owner

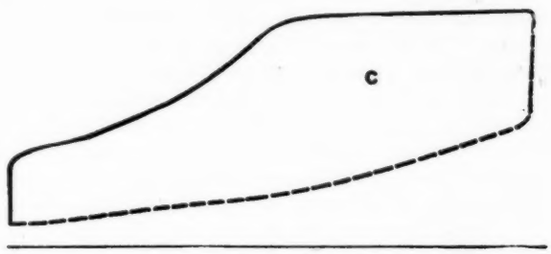


FIG. 5. CRANK-END CORRECTED DIAGRAM

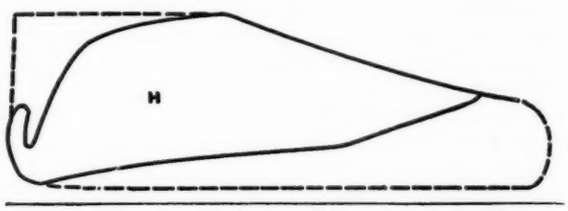


FIG. 6. DIAGRAM WITH IMPROVED VALVE SETTING

of the engine from which they were taken, concluded that it was overloaded, hence bought and installed a larger boiler. Investigation showed that the defective diagram from the head end was caused by a loose key in the valve stem and a leaking cutoff valve. In Fig. 6 the dotted lines show the improvement that could be secured by applying a remedy to these defects. The increase in the indicated power is 68 per cent for one end, which is 34 per cent for the whole engine, without taking any more steam from the boiler. If this increase in power was not wanted, a corresponding reduction in the amount of steam used would have been the natural result.

The hot rolling of spur, bevel and other types of gears, with an accuracy and perfection of finish equal to that of machining, is now an accomplished fact, according to a recent article in the *Blast Furnace and Steel Plant*. A machine is there described in which a gear is ordinarily rolled in about fifteen seconds. The gear blank, heated to forging temperature, is fastened to the end of a shaft that revolves at from 400 to 700 r.p.m., while the forming gear, or die, is fastened to another shaft in such a way that it can be gradually forced against the blank while the two are revolving. Correct spacing of the teeth is obtained by gearing at the other ends of the shafts. Rotation is continued a few seconds after the blank has cooled below the critical temperature, so that the surface of the formed piece is planished. The main advantage of the process, of course, is its great speed and corresponding low cost. In addition to that, shrouded pinions can be made readily, and so can herringbone spur and even herringbone bevel gears. The inventor, H. N. Anderson, received a medal for one of his early machines in 1915 from the Franklin Institute.

Determining Sizes of Motor Circuits for Peak-Load Duty

By EDGAR P. SLACK
Assistant Electrical Engineer, Underwriters' Laboratories

VARIOUS examples are taken of motors that are operating under severe conditions, and problems are worked out to show how to compute the size of conductors.

IT IS specified in the National Electrical Code that the line supplying a motor shall have a carrying capacity of at least 110 per cent of the name-plate current rating of the motor. The Code then goes on to recommend larger wire sizes for certain classes of service and for certain kinds of motors, this matter having been touched on, but not discussed, in an earlier article. Taking up first the subject of motors for certain classes of service, the Code makes the following suggestion:

To provide for the peak loads which are encountered in certain classes of service, such as operating valves, raising or lowering rolls, rolling tables, hoists, elevators, pumps, etc., without overfusing the conductors, motors will sometimes require cables considerably larger than 110 per cent of the motor name-plate current rating. In the majority of cases the current-carrying capacity of conductors complying with the rule will not exceed the percentages of the name-plate current ratings of the motors given in the following table:

Classification of Service	Percentage of Name-Plate Rating				
	5 Min. Rating	10 & 15 Min. Rating	30 and 60 Min. Rating	2-Hour Rating	Continuous Rating
Operating valves raising or lowering rolls	110	120	150	200	250
Rolling tables	110	120	135	180	200
Hoists, rolls, ore-and coal-handling machines	110	115	120	150	170
Freight and passenger elevators, shop cranes, tool heads, pumps, etc.	110	110	110	120	140

The reason for recommending larger wire sizes in these cases is that these motors, being used for peak loads, draw a heavy current from the line. This current is sufficient to blow the line fuses unless these fuses, and consequently the wires, are of large size. Suppose, for instance, it were attempted to run a motor used for operating a hoist on a line with a capacity only 110 per cent of the motor rating. If the motor has a 2-hour rating of 75 amperes, the line capacity would then be 110 per cent of 75, or 82.5 amperes, which would call for a No. 2 B. & S. gage wire, rated at 90 amperes, and which could not be fused over 90 amperes. Now, under ordinary working conditions the sudden, heavy loads that are put on hoists would probably cause the motor to draw currents far above 90 amperes, and the line fuses would fail. It is therefore necessary to use larger line fuses and consequently larger line wires. In this case reference to the table shows that if the line is made 150 per cent of the motor rating, the line cutouts may be expected to hold in ordinary service. Therefore, for this case a line capacity of 150 per cent of 75, or 112.5 amperes is used, which would call for a No. 0 B. & S. gage conductor, rated and fused at 125 amperes.

It will be noted that the recommended size of wire depends on the severity of service to which the motor is subjected. Thus, if the motor referred to, with a 2-hour rating of 75 amperes, were to be used in a steel mill for raising or lowering rolls, it would be subjected to heavier overloads than for hoist operation, and even 125-ampere fuses would probably blow. For this reason a still larger size is suggested for this extremely heavy duty; namely, 200 per cent of the motor rating, as shown in the table. In this case the line capacity figures out 200 per cent of 75, or 150 amperes, which calls for a No. 00 wire, rated and fused at 150 amperes. On the other hand, where the service is lighter and the current inrush from peak loads is not so great, the fuses and wires may be correspondingly smaller. Referring again to the same motor, but used for an elevator, 125 amperes would probably be an unnecessarily large capacity, and the table shows that 120 per cent of 75, or 90 amperes, would generally be sufficient. This would call for a No. 2 B. & S. gage conductor.

The table also shows that with motors used for the same duty but having different time ratings, different wire sizes are recommended. Motors are rated at the amount of current that they can carry for a given length of time without overheating. Thus, a motor with a 2-hour rating of 75 amperes would carry that current for two hours without overheating. For a shorter time it could carry a larger current with the same heating, and if a similar machine were to be given a 10-minute rating by the manufacturer, the 10-minute rating might be 100 amperes. On the other hand, such a machine rated for continuous operation would have a smaller rating, perhaps 65 amperes.

Suppose there are three hoists, used for similar duty and operated by motors of similar type and size, the first motor having a 10-minute rating of 100 amperes, the second motor having a 2-hour rating of 75 amperes, and the third having a continuous rating of 65 amperes. The size of line recommended in the table for the three cases is as follows: In the first case, 115 per cent of 100, or 115 amperes; in the second case, 150 per cent of 75, or 112.5 amperes; and in the third case, 170 per cent. of 65, or about 111 amperes. In either of these cases the line size called for is No. 0 B. & S. gage, rated at 125 amperes. It is to be expected that the current required from the line to do the same work would be approximately the same in each case, and that therefore the wire size would be the same, as is borne out by this sample computation. In actual practice the table would probably not give results agreeing so closely as these, as it is drawn up to represent the average conditions of various installations, with various kinds of motors and driven machinery.

Except for the requirement that all conductors of a motor circuit shall have a carrying capacity of at least 110 per cent of the motor rating, all the foregoing figures on wire sizes are merely suggestions and recommendations, intended to aid the engineer and others in estimating and installing the circuits. In some cases, by making a study of the starting characteristics of the motor and the special conditions of loading imposed by

the machine to be driven, it might be found possible to use a smaller fuse and wire than suggested. There are also probably some cases where the starting conditions are extremely severe and where the size recommended would be found too small. In the majority of cases, however, the sizes recommended, while not so large as to be wasteful, will be found large enough to prevent the blowing of the line fuses under normal operation.

Installing New Boilers Without Stopping the Plant

Two new 72-in. x 18-ft. horizontal return-tubular boilers, recently installed at the plant of the John R. Carpenter Co., at Jamaica, N. Y., were set up under quite unusual conditions. They were placed directly over two existing boilers of about the same size, and one boiler had to be in operation at all times during the installation.

The old boiler-room floor was twelve feet below grade, and the ceiling, which was of concrete arches on steel beams, was six feet above grade and formed the floor of a dry kiln that was out of use.

It would have been a relatively simple matter to replace the worn-out boilers by new ones in the same location, but the firing conditions made it highly desirable to install the new boilers at grade and level with the adjoining engine room. The original conditions are shown in Fig. 1.

The change was carried out as desired, without a shutdown, and it was necessary to work over-time only twice—when the new boilers were hung above the old ones and when the new piping was connected to the existing mains.

The first step in the construction work was to remove the concrete floor arches, leaving the steel beams to protect the old boilers below, while the new ones were being rigged. The suspension columns were set up outside the walls and the suspension beams erected. The new boilers were brought in through what had been the kiln doorway, and hung in position.

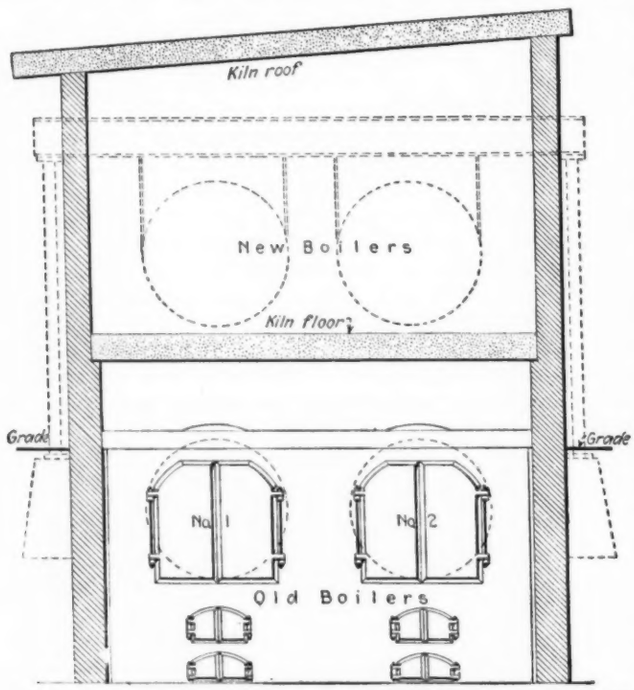


FIG. 1. POSITIONS OF THE OLD AND THE NEW BOILERS
No. 2 was removed and the new one installed above it while No. 1 was kept in operation.

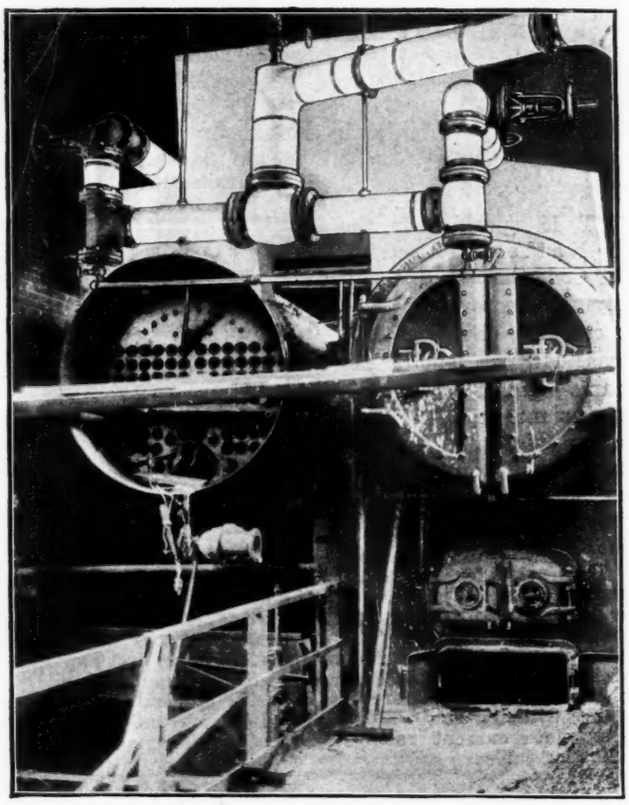


FIG. 2. ONE NEW BOILER READY FOR OPERATION
Note the front of old boiler No. 1 in the lower left-hand corner.

The steel beams were removed and placed in front of the new boilers at grade to support the new firing floor. Old boiler No. 2 was cut to pieces by torch and removed. Its setting was then bricked up across the front and the interior filled with sand up to grade. The old walls were thus used as foundation for the new settings. The new flue and steam header were prepared at the same time.

The stack of the plant is a square brick chimney with walls 16 in. thick at the base. An opening for the new flue four feet square was cut in to a depth of 12 in., leaving a 4-in. curtain. The new flue was set in and the curtain broken down with a bar through a large clean-out door placed at the bend of the flue, thus avoiding over-time work.

The steam main was connected to the new header on a Saturday afternoon and Sunday morning, and on Sunday afternoon the engine was run with steam from the new boiler. The temporary firing floor was of 3-in. plank covered with two inches of cement grits laid with wire cloth. Fig. 2 shows the conditions at this stage of the work.

The dismantling and removal of old boiler No. 1, which may be seen at the lower left-hand corner of Fig. 2, went on in the same manner, the new boiler being bricked in and connected to the flue and to the steam header. A trap was left in the new floor, and the old firing space beneath is being gradually filled up.

The installation was designed and supervised by Gilbert & Ashfield, consulting engineers, and the work was done by the Frederick Page Contracting Company.

A Few Facts About Steam- and Electric-Driven Refrigerating Plants

By G. E. PORCE

USUALLY, three sources of power are available for refrigerating plants: (1) Central-station energy; (2) steam power; (3) oil-engine power. For a locality far removed from central-station service and coal supply, the oil engine will prove the best. In fact, the more modern oil engines are as reliable as the electric or steam power and are coming into general use for compressor drive. In this discussion, however, comparison will be made between the electric motor and steam power only. Central-station electric power is particularly attractive when it is easily available and at reasonable rates, since it eliminates the steam-boiler plant with its handling of coal, ashes and water, all the troubles that go with the boiler room, steam condenser, steam piping, and the additional space, upkeep and investment required.

On the other hand, electric power is often unsatisfactory and is always subject to interruptions and damage to equipment from short-circuits and storms. Furthermore, the cost of electric power in certain localities is no criterion for other sections of the country. In the middle section of the country the condensing pressure averages from 145 to 180 lb. gage pressure, while in the South it is not unusual for plants to operate at an average of 200 lb. and higher throughout the hot summer months. With the same cost per kilowatt-hour the high-pressure plant will find the cost per unit of output much above the low-pressure plant costs.

NUMEROUS refrigerating engineers have discussed, before the societies and in the publications, the advantages of electric drive for refrigerating machines. Few, however, have made a fair comparison between the electric motor and other prime movers.

It is of first importance to look well into the question of dependability of power and cost of power before contracting with a central power station. The consumer should make sure that the station has a sufficient reserve capacity to give steady service. The form of contract must likewise be considered carefully, for the cost is usually based on a maximum demand charge plus a sliding-scale rate on the kilowatt-hours consumed. Since this demand-charge item covers a large part of the power bill, its exact determination and application must be carefully checked. To secure current at a minimum cost, it is necessary to keep the plant load factor high, and this calls for a large ice-storage capacity in order to avoid peak loads which will run the power costs up to a surprising degree, or in other words, to maintain a uniform power demand for twenty-four hours a day for the entire year.

There is always the possibility of the cost being raised through state control of rates even though a contract has been signed with the central station. To illustrate with a specific case, A. M. Dixon, a prominent ice manufacturer, of Savannah, Ga., talking before the last meeting of the Southern Ice Exchange, advised that he contracted for power for a five-year period beginning Feb. 1, 1920, at a fair rate, but that on Aug. 1, 1920, the Railroad Commission of Georgia cancelled his contract and allowed an increase that averages about 41 per cent per year. This high increase was due to the application of a demand charge plus monthly current consumption, the demand charge constituting a large proportion of the total charge. In this particular case the new demand charge was based on the highest demand for any fifteen-minute period during any summer month, and it applied for six months following and including the month in which it was established. Last year the highest demand reading was taken in June, when the peak load was on and resulted in this high charge being in effect through December, whereas the plant was operated at only fractional capacity all through the fall and winter.

The disadvantages of the steam boiler plant have been briefly mentioned. Its advantages are: (1) Flexibility as to speed, hence capacity; (2) continuous service, being unaffected by storms, etc.; (3) placing the power within the control of the plant owner.

Continuous service in an ice plant is, within reasonable limits, even more important than running efficiency. In addition to the foregoing features, the medium and large steam-driven plants using modern unaflow and poppet four-valve engines are more economical than the average electric-driven plant under the conditions usually met with. This is shown by making a com-

COMPARISON BETWEEN STEAM AND ELECTRIC-DRIVEN RAW-WATER ICE PLANTS

Type of Plant	Capacity of Plant, Tons Ice-Making	Size of Ice Storage, Cubic Feet	Ice-Storage Capacity, Tons of Ice	Cost of Ice-plant Building Complete Including Daily Ice Storage	Cost of Large Ice-storage Building, complete	Cost of Refrigerating and Ice-making Machinery and Power Equipment Complete	Total Cost of Plant	Interest, Taxes, Depreciation and Maintenance Charges per Ton Ice, Cents	Estimated Executive and Labor Cost per Ton Ice, Cents	Fuel, Water and Supplies Cost per Ton Ice, Coal at $6 per Ton, Cents	Electric Power, Water and Supplies Cost per Ton Ice — Annual Current @ ½c. per Kw.-Hr. Total Average Rate, Cents	Total Cost of Ice per Ton
Steam-driven	100	500,000	10,000	$36,000	$80,000	$84,000	$200,000	80	72	45	....	$1.97
Electric-driven	100	500,000	10,000	32,000	80,000	73,000	185,000	74	59	....	90	2.23
Steam-driven	50	75,000	1,500	23,000	18,000	45,000	86,000	105	140	48	....	2.93
Electric-driven	50	75,000	1,500	20,000	18,000	40,000	78,000	95	114	....	103	3.12

Depreciation and maintenance on machinery, 6 per cent; on building, 4 per cent; petty expenses, 1 per cent; interest on investment, 6 per cent; taxes, 3½ mills per dollar at ½ value; insurance ½ of 1 per cent per year.

parison of a 50- and a 100-ton plant, using throughout the data and figures experience has proved to be fair averages. For some localities the basis assumed will be high and for others low. The same basis of construction, machinery and equipment and labor costs having been used for both the steam and the electric plant; even if this basis is not correct for a given locality, the relation between the two types of plants remains fairly constant. The comparison is given in the table and is based on good brick buildings, first-class cork insulation for ice tanks and storage rooms, and in both cases the use of water-cooling towers with a continuous recirculation of water, allowing 5 per cent for makeup. The electric plant has direct-connected synchronous motor-driven compressor and motor-driven auxiliaries throughout. The steam-driven plant has water-tube boilers with superheaters arranged in two units, each equaling three-fourths of the plant capacity, barometric steam condenser with vacuum pump, unaflow poppet-valve steam engine direct-connected to the compressor, and motor-driven auxiliaries throughout, with a direct-connected unaflow-engine-driven generator to supply current.

Other plant parts are the same in each case and include fourteen 300-lb. standard ice cans and 240 lin.ft. of 1¼-in. freezing-tank coils per ton of ice, flooded freezing system, medium-pressure air-agitation raw-water system, electric crane for lifting four cans and automatic can filling at the ice dumps. Should a low-pressure air system be used instead of the medium-pressure system, both the first cost and the operating costs of the plant would be somewhat lower. The current and steam consumption used in each case are being averaged in daily practice in plants of the type under consideration.

The fact that the steam-driven plant shows the lowest ice-making cost is reasonable when the comparison is made on the average steam-driven central-station power charge; namely, 1¼c. per kw.-hr., average current cost. The central station has its coal bill, upkeep, labor costs, etc., the same as the steam-driven ice plant and in addition has a higher overhead plus a legitimate profit. The difference gained by the central station on account of its possible higher efficiency is largely offset by line losses, higher administrative overhead and profit. Each case must be compared carefully on the basis of local rates and conditions before a decision is made as to which type of power to use, and no offhand statement as to the superiority of either source of power is of any value. If the engineer will make his calculations somewhat on the basis of the table, a result that may be considered fair to both types of power will be obtained.

Several Methods of Finding the Clearance Volume of an Engine

IT IS necessary to know the clearance in the engine cylinder before it is possible to find the mean effective pressure and the point of cutoff by computation or to calculate the water accounted for by the indicator diagram. In addition it enters into the problem of compounding, most advantageous receiver pressure, transformation of the pressure-volume diagram to the temperature-entropy diagram and in many other problems of indicator work. For these reasons the engineer should become acquainted with the methods employed to find the clearance volume in engines where such data are not otherwise available.

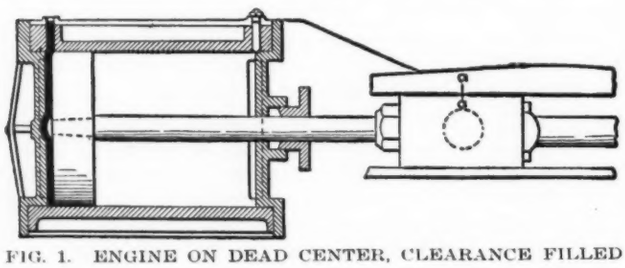


FIG. 1. ENGINE ON DEAD CENTER, CLEARANCE FILLED

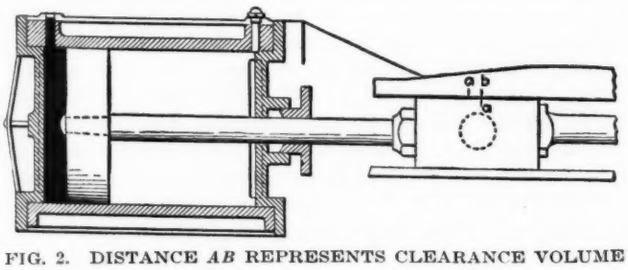


FIG. 2. DISTANCE *AB* REPRESENTS CLEARANCE VOLUME

One of the methods that was early adopted was that of placing the engine on dead center and filling the clearance with water. By weighing the amount poured in, the cubical contents may be readily computed. A pound of water at ordinary room temperature has a volume very close to 27.7 cu.in. This volume allows the clearance volume in cubic inches to be computed readily.

To find the weight of water filling the clearance, several methods have been used. The most simple one is to set the engine on dead center and then pour in water out of a weighed pail until the clearance is filled. By weighing the pail and remaining water, the difference between this and the original weight of the pail and contents gives the pounds of water poured into the clearance. The product of this weight and 27.7 gives C, the clearance in cubic inches.

The percentage of clearance is then found by computing the cylinder area and the stroke and then dividing the clearance volume as previously obtained by the product of the area and stroke. As an example, five pounds of water fills the clearance, giving a clearance volume of $5 \times 27.7 = 138.5$ cu.in. Assuming that the engine cylinder is 12 in. in diameter and has a 36-in. stroke, the cross-sectional area A, or $9.7854\,D^2$, $= 0.7854\ (144) = 113.1$ sq.in. The stroke is 36 in., giving a stroke volume of $AS = 113.1 \times 36 = 4{,}071.6$ cu.in. The clearance is $\frac{C}{AS} = \frac{138.5}{4{,}071.6} = 0.034$ or 3.4 per cent.

If a scale or balance is not handy, the clearance may be computed from the volume of water poured into the space. The amount of water in gallons, quarts, pints

and gills may be converted into cubic inches by the following table:

1 gallon	=	231 cubic inches
1 quart	=	57.75 cubic inches
1 pint	=	28.88 cubic inches
1 gill	=	7.22 cubic inches

If, for example, 3 quarts, 1 pint and 3 gills of water is needed to fill the clearance of an engine with a cylinder 15 in. diameter by 16-in. stroke, the volume becomes

3 × 57.75	=	173.25
1 × 28.88	=	28.88
3 × 7.22	=	21.66
Total	=	223.79 cubic inches.

The area of the engine piston is $0.7854 \times (15)^2$ and the stroke is 16 in., giving a stroke volume of $AS = 0.7854\ (15)^2 \times 16 = 2{,}827.44$ cu.in. The percentage of clearance is then $\frac{223.79}{2{,}827.44}$ or 7.9 per cent.

The percentage of clearance may be obtained directly, without any computation of the cylinder volume. If we have a cylinder, as Fig. 1, with the indicator opening at the top, the crank should be placed on dead center and marks *aa* made on the crosshead and guide as shown. Removing the indicator plug, enough water is poured into the clearance to fill it up to the indicator opening. The engine is next

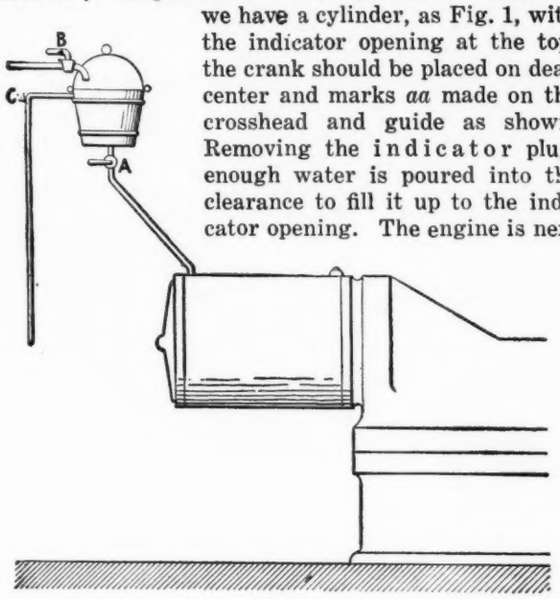


FIG. 3. ANOTHER METHOD OF FINDING CLEARANCE

turned on past dead center a few inches. An amount of water just equal to that which has been poured into the clearance space is now poured in through the indicator connection. The piston is brought back toward dead center until the water just fills to the top of the indicator opening. If a mark *b* on the guide be made opposite the mark *a* on the crosshead, the distance *ab*, Fig. 2, represents that part of the stroke volume which is equal to the clearance volume. Measuring *ab* and dividing by the stroke in inches gives the percentage of clearance.

Still another method is illustrated in Fig. 3. Here a vessel having a connection *A* at the bottom and an overflow line *C* toward its top, is placed close to the engine. The bottom line is led to the indicator opening, and a water-supply line *B* is led to the vessel. The bucket is filled and the bottom cock is opened. The time in minutes and seconds, required to fill the clearance is noted. During this time the supply should be ample to keep the water at least level with the overflow. Now if the bottom line be allowed to discharge into a bucket, the weight of water discharged in a period of time equal to that taken to fill the clearance represents a weight of water equal to that put into the clearance. This is for the reason that under a constant head (the height of the water in the bucket above the discharge-pipe outlet) the weights of water discharging through a given orifice in equal time intervals are the same.

These methods of determining the clearance volumes depend on the tightness of the piston and valves. If water leaks around the piston or the valves, the results are of course unreliable.

In slide-valve engines the valve is often placed vertically at the side of the cylinder as in Fig. 4. When the indicator opening is

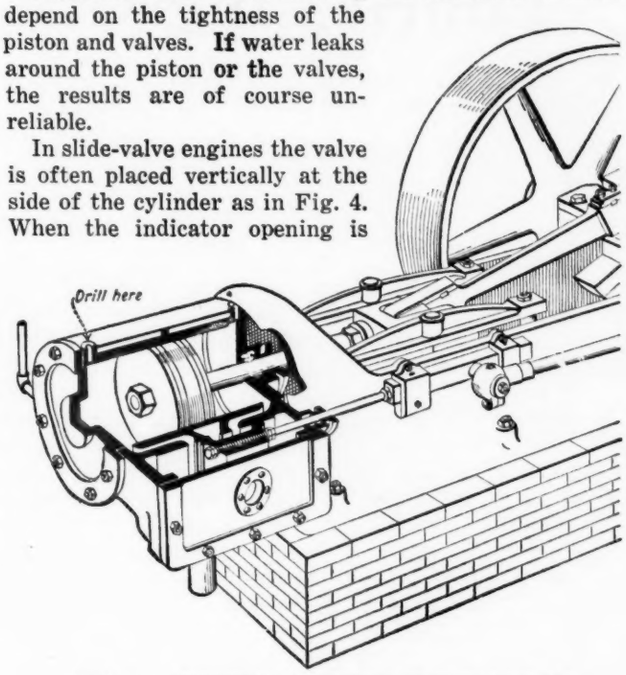


FIG. 4. REMOVING AIR FROM CLEARANCE OF SLIDE-VALVE ENGINE

placed at the side as is usual, an elbow and two nipples must be used to bring the level of the orifice up to that of the top of the cylinder. Since some air will be trapped in the clearance space, the volume of water will not accurately represent the clearance volume unless the air be removed. If no opening leads to the clearance from the top, it is necessary to drill a small air-relief opening into the clearance space, as shown in Fig. 4.

The valve in all the methods outlined must be blocked to cover the port opening, or the water will leak out

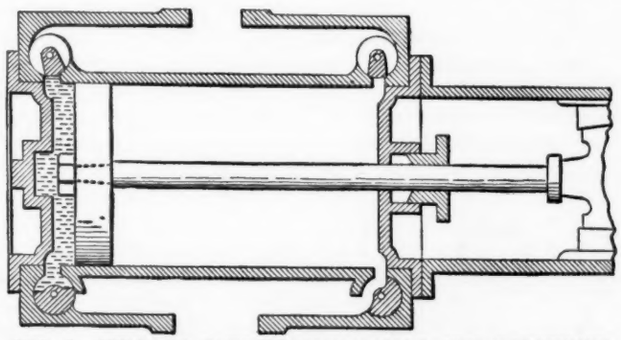


FIG. 5. FILLING CORLISS CLEARANCE AND REMOVING THE AIR

into the exhaust connections or into the steam chest.

With Corliss engines the air may be relieved by moving the steam valve, Fig. 5, open a slight amount. The top of the pouring piping must be on a level with the steam-valve seat, for the clearance volume includes the port volume as well as the volume included between the cylinder head and piston.

Necessity of Heating and Cooling Lubricating Oil

AN essential feature of a circulatory oil system is a heater to break down any emulsion. A cooler must also be used to reduce the temperature to a reasonable value. If, however, the temperature is carried too low, the tendency to emulsify is increased. The correct temperature depends upon the characteristics of the oil.

By W. F. OSBORNE
Supervisor Manufacturers' Service, Texas Company

ONE of the advantages of the circulatory system of lubrication is that it permits the continuous supply of a considerable quantity of oil to all bearings, carrying away the generated and conducted heat and lowering the bearing temperature. In many systems the amount of heat taken up by the oil in its passage through the bearings is not large and can readily be given up to the air by direct contact or by conduction through the metal of the pipes and reservoirs.

When the heat is given off by the oil as fast as it is received from the bearings, the oil never becomes seriously hot and will always be delivered to the bearings at a sufficiently low temperature to keep them cool. In some types of circulatory systems, however, the heat generated in the bearings is large and the amount of heat received from steam cylinders, steam-turbine casings, direct radiation from furnaces or material in process of manufacture is greater than can be given off to the air and metal in contact with the oil. In such systems the oil temperature is likely to become so great that it will not keep the bearings at a sufficiently low temperature, the viscosity may be reduced to a point where it will fail to prevent metallic contact, the evaporation and deterioration of the oil will be excessive and results will be unsatisfactory.

Such conditions very frequently can be improved by the installation of a suitable oil cooler. The cooler, consisting usually of a shell containing a number of pipes, permits the oil to flow along one side of the pipe wall and the cooling water along the other. The cooling water absorbs the heat from the oil and lowers its temperature. There are a number of good coolers on the market, their efficiency depending upon the suitability of the particular size selected for the conditions of the individual installation.

The oil coming in contact with the cool metal is reduced in temperature and its viscosity raised. The high-viscosity oil is moved more slowly than the thinner oil, which is a little farther away from the metal, with the result that the hot thin oil is prevented from coming in direct contact with the cooling coils by the insulating effect of the oil that has already been cooled. The higher the viscosity of the oil, the greater will be this insulating effect and the lower will be the efficiency of the cooler. When the oil is pumped through the pipe, the cool thick oil adheres to the sides of the pipe, and the hot oil flows rapidly through the center without being cooled very much. The best type of cooler is one in which the velocity of the hot oil tends to scour the cooled oil off the cooling surface, thereby giving the hot oil a chance to be lowered in temperature.

The rate of heat transfer from the oil to the cooling water increases with the velocity of the oil and the water and decreases as the viscosity of the oil is increased. It is much easier to cool any oil from 160 to 125 deg. F. than it is to cool the same oil from 150 to 115 deg. F., although the temperature drop is exactly the same in each case.

Cooling the oil increases its viscosity and, if the temperature is carried too low, will result in increased bearing friction. The amount of cooling allowable will depend on the desired viscosity of the oil at the operating temperature. If it is not cooled enough, the bearings may become dangerously hot; if the temperature is reduced too low, the power losses will be raised.

Cooling the oil also increases its tendency to emulsify or to carry moisture and foreign matter in suspension. The temperature should never be allowed to become so low that separation of water and other foreign matter is imperfect. In one instance, on a very large steam turbine the engineer insisted on cooling the turbine oil to 90 deg. F. as soon as it left the bearings. He was

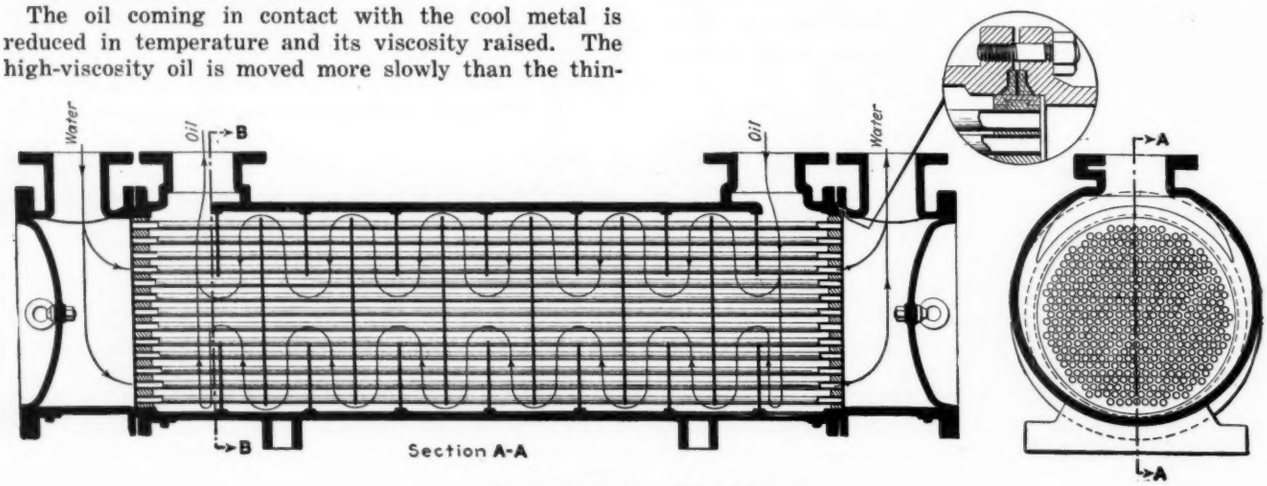


FIG. 1. TYPICAL OIL COOLER

getting a considerable amount of sludge and blamed the quality of the oil. An analysis of the oil going to the bearings from the filters showed 7½ per cent moisture, which was the cause of the sludge. He had reduced the temperature of the oil to a point where the viscosity was so great that the moisture would not properly separate from the oil and the sludge was a natural result.

In starting up any machine lubricated with the circulatory system, it is always good practice to leave the cooling water turned off until the oil has reached the

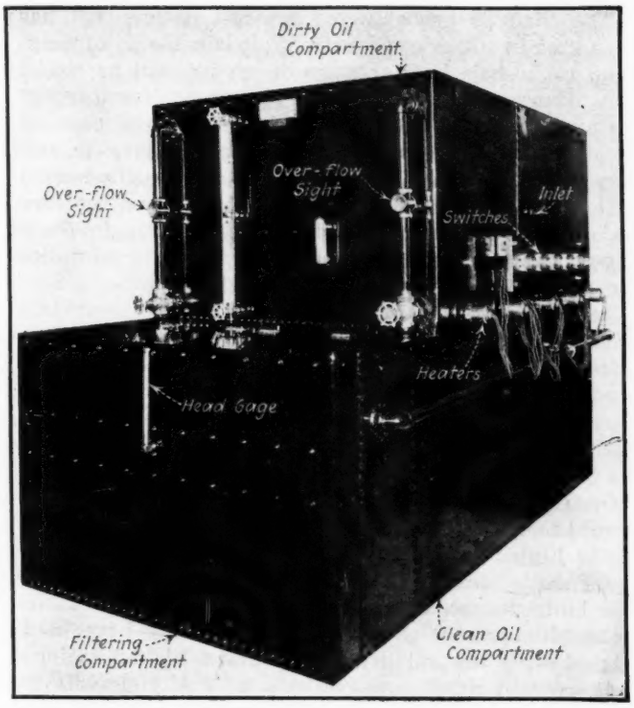


FIG. 2. FILTER IN WHICH THE OIL IS HEATED BY ELECTRIC COILS BEFORE BEING FILTERED

usual operating temperature, so that normal conditions will be reached as soon as possible. This prevents the possibility of trouble when the machine is first placed in operation.

As a low viscosity and a high temperature improve the cleaning of the oil, it should always be passed through the filtering system before going to the coolers. In some systems, which require the use of a very heavy-bodied oil at low temperatures, the oil may be so viscous as it comes from the bearings that it will not clean up properly. Then it becomes necessary to lower the viscosity by artificial heating of the oil, thereby giving the moisture and other foreign material a chance to separate. The heater, which is usually built just like the cooler, except that steam instead of cooling water flows through it, is placed in the drain line from the bearings. The hot oil is then sent through the filters, and after being thoroughly cleaned, it is passed through coolers to raise it to the proper viscosity required for lubrication.

The principal thing to watch in connection with heaters is to install them so that there will be no tendency for local overheating and carbonization of the oil, as this decomposition is more destructive than the presence of moisture. When an electric heater or a steam coil is submerged in a very viscous oil, the oil immediately surrounding the heater is raised to a high temperature, but on account of the viscosity of the oil a little farther away, there is a very poor circulation and the heavy oil receives little heat, while the oil next to the heater gets excessively hot. Oil is not a very good conductor of heat, and unless forced circulation is provided there is likely to be overheating and carbonization of the oil.

Heaters and coolers properly arranged are very advantageous in most circulatory systems. They are particularly valuable in any system where there are various kinds of surfaces which must be lubricated with one oil. The lubrication of reduction gears and their bearings is an instance of two widely differing classes of lubricating requirements. Gears require much higher viscosities than do bearings. An oil suitable for the bearings would be entirely too light for the gears, and an oil of the proper viscosity for the gears would be too heavy for the bearings. When one circulatory system is used for both, an oil may be selected of the correct viscosity at the operating temperature of the gears. It can then be reduced to the correct viscosity for the bearings by raising the temperature.

The same effect can be secured by selecting an oil of the correct viscosity for the bearings at their normal operating temperature, and cooling a part of it to the necessary temperature to secure the right viscosity for the gears.

It is not always a good thing to have the lowest possible temperature in a circulatory system. Much better results from all angles may frequently be secured by raising the temperature somewhat. Rather than try to secure as great a cooling effect as possible, it is much better to regulate the flow of water through the cooler so as to maintain the oil at the correct viscosity for the bearings, thereby securing the very lowest bearing frictional losses possible.

Green Chain Grate for Forced or Natural Draft

A new forced-draft chain-grate stoker designed to burn bituminous coal with equal responsiveness under either natural or forced draft, as the load demands, has been developed by the Green Engineering Co., of East Chicago, Ind. This has been accomplished by making the air space in the chain practically the same as in the natural-draft stoker, although it is more finely divided to insure uniform distribution of the air and to reduce sifting of fine coal through the chain to a minimum. Low blast pressures therefore are used, and comparatively little power is required to drive the fan.

An outstanding feature is the introduction of the forced blast into a large chamber underneath the stoker, from which the air passes up around the sides into the compartments between the upper and lower runs of the chain. Large volumes in the compartments and in the air chambers below are provided to insure uniform air pressures. Cast-iron stools support the side walls, so that there is no brickwork below the line of the fuel bed for the full length of the stoker.

Controls for all dampers are carried to the front of the stoker so that the operator can make adjustments within view of the instruments, and incidentally this arrangement leaves the aisle between boilers free of obstructions. Another noticeable feature is that the

fuel bed is surrounded on the three active sides by water-cooled members. The arrangement by which the lower run of chain automatically removes the siftings is also of interest.

The stoker has five compartments, each sealed from the others, as indicated in Fig. 1. The cast-iron stools previously referred to are shown in the crosswise section of the stoker in Fig. 2. They are spaced at intervals corresponding with the partitions between

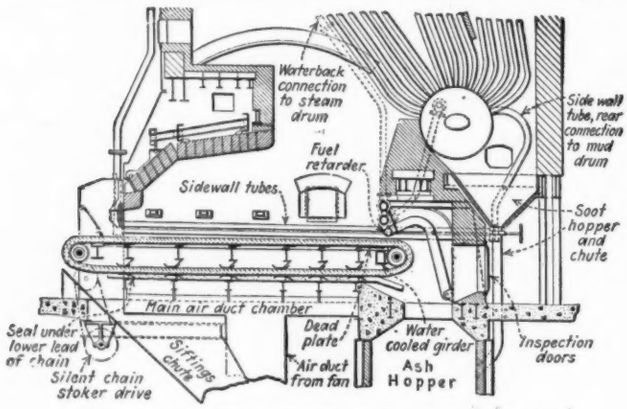


FIG. 1. THE STOKER HAS FIVE AIR-SUPPLY COMPARTMENTS

forced-draft compartments, and they support the steelwork, which in turn carries the boiler side walls. Transversely from these stools are channel-iron beams spanning the furnace and forming the framework of the stoker. On top of these channels are cast-iron air seals placed between the skids on which the chain rides, and below them are hung swinging air seals. Beneath the entire lower run of stoker chain the seal is made by means of solid flooring. This construction allows the lower run of chain to drag forward to the front of the stoker such siftings as may pass through the grate and deposit them in a droppage hopper, from which they may be returned to the coal conveyor.

Reference to Fig. 2 will show the large air-pressure chamber underneath the stoker. At either side of it are dampers, which admit the forced draft into each of the five compartments shown in Fig. 1. Doors at the side of the vertical passage admit the natural draft. In the illustration both the forced- and natural-draft dampers are shown closed, but in operation either one set or the other is open, depending upon the service required. The change from forced to natural draft or back can be made quickly by means of levers at the front of the stoker. Each of these levers controls both forced and natural draft for one of the five compartments. The connection between the hand levers and the operating levers next to the different compartments is made through telescoping pipes.

The chain is probably the heaviest design that has been used in stoker construction. It is made up of deep, thin, round-hole links, strung on either oval or round bars, the oval bar construction being preferred, as it permits the quick replacement of a link in case of breakage. A continuous variable-speed drive is employed. The adjustable ledge plate construction used with the natural-draft stoker is retained, and the new water-cooled fuel retarder, described recently in these pages,[1] has been incorporated in the design to minimize the passage of unburned carbon to the ashpit.

To offset the known deterioration of furnace brickwork at high ratings, protection is afforded at both sides and at the rear. The water-back is of the return bend design, and on the side walls are two tubes, one above the other, terminating in manifolds at the ends. Each of these water-cooled members is connected into the boiler circulation.

One of these stokers has been under observation for several months at the Mill Street Station of the Indianapolis Light and Heat Co., where it has been tried under wide variations of central-station conditions. The builder reports most satisfactory results. Loads up to 150 per cent of nominal boiler rating have been carried with natural draft, and much higher ratings under forced draft are available at any time. It is stated that under natural-draft operation the stoker drive requires less than one-half of one per cent of the steam generated, and that the total auxiliary power requirements are less than 2 per cent, as the fan requires only moderate driving power on account of the low air pressures employed.

[1] See *Power*, March 21, page 459.

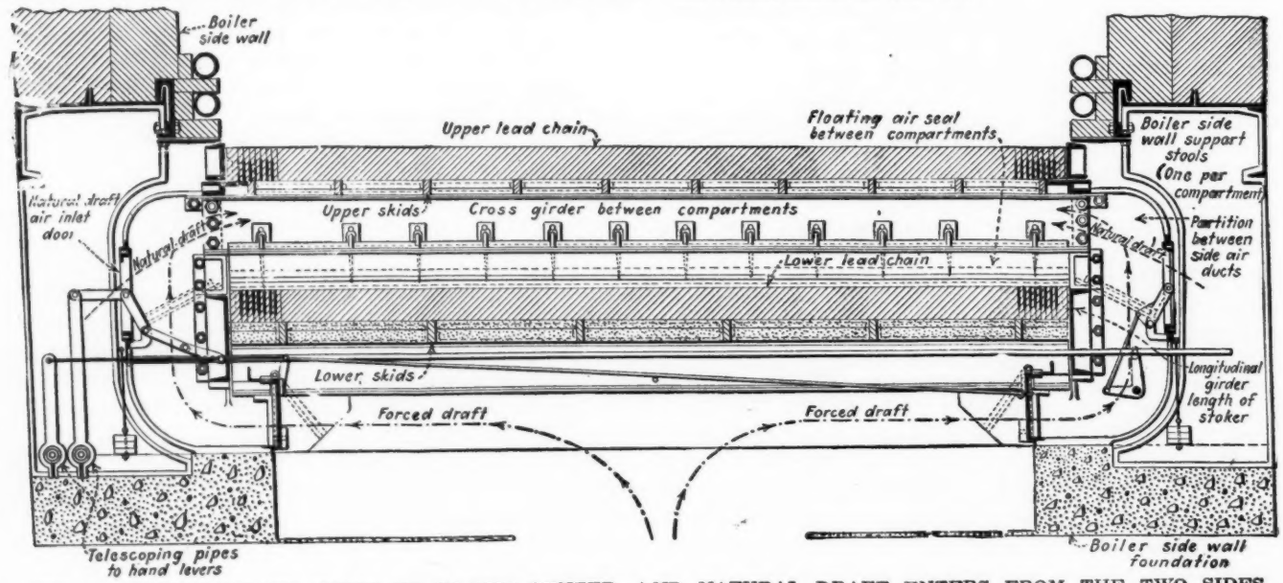


FIG. 2. FORCED DRAFT COMES UP IN THE CENTER, AND NATURAL DRAFT ENTERS FROM THE TWO SIDES. EITHER DRAFT MAY BE USED, ACCORDING TO STEAM REQUIREMENTS

EDITORIALS

By Name or By Analysis

FREQUENTLY coal purchasers depend upon the name of coal as a basis for selection. This is a rather loose but still valuable guide to coal quality for, unquestionably, district names do indicate at least approximately, the character of the coal, and if it is purchased through reliable dealers the purchaser is reasonably secure. However, under the present disturbed conditions new factors enter to affect the buyer's judgment.

In the first place, coal production in most districts has been interrupted for two months. Even where production has continued, it is uncertain as to how uniform the quality of output may have been, because strike conditions often affect districts that are not on strike. Furthermore, stocks of coal, large though they were at the outset, are beginning to show signs of depletion in some localities. All this means that the average buyer cannot depend upon his usual sources of supply for further indefinite periods.

Before the time arrives when he must necessarily go into the market to experiment with new kinds of coal, it is desirable to find out the essential characteristics of the coal for his particular plant. It will be well to go over back records and ascertain the fusing point of the ash and the analysis of the coal that has been successfully employed. Armed with these data, the purchaser can judge intelligently regarding the value of any coal that may be offered.

It may not be a time when the discriminating buyer can pick and choose as fully as he would like; but it will still be possible, even under conditions of limited supply, to judge somewhat between the various offerings Certainly, he who goes knowing what he needs, will stand a much better chance of getting a satisfactory fuel during that period, which perhaps may yet continue for many weeks, until normal channels of supply again are open.

Inspection and Maintenance of Power-Plant Equipment

AS THE sizes of power systems become larger, the question of continuity of service takes on greater importance. Continuity of service is dependent upon two factors—the proper installation of reliable equipment and keeping it in a high degree of maintenance The latter can be accomplished only by a systematic procedure of inspection. Proper maintenance is not making repairs after something has happened, but making the repairs at some convenient time before the defect has had an opportunity to cause an unexpected shutdown. A minor defect in the governor or emergency valve on a turbine, if discovered and repaired in time, may cost an inconsequential amount. On the other hand, failure to correct the defect may result in a disastrous wreck as attested by numerous examples. What is true of the turbine is also true of many other parts of the power plant.

In the modern power plant much of the apparatus is automatically or remotely controlled, consequently its operation is not visible to the operator. For this reason failure to function at the proper time may have more serious effects than if the equipment was hand-operated and situated where its operation could be seen by the operator. This naturally makes the equipment require more exacting attention than might otherwise be necessary, since the proper operation of automatic-control equipment can be insured only through proper inspection and maintenance.

It would be difficult to over-emphasize the importance of a systematic routine of inspection. However, there is danger in involving the operating organization into a maze of red tape, which will not only discourage the initiative of those who have to keep the wheels turning, but also create in them a tendency to be antagonistic toward anything that looks like system. Any system of inspection should be made as simple and easily applied as possible and yet produce the desired results; that is, each piece of equipment should receive the necessary attention and at the proper time.

Inspection and maintenance systems are like almost anything else, in that there is no standard method; what may be suitable to one installation with set conditions may not be suitable to another. Therefore, careful study must be given to what it is desired to accomplish before introducing such a system, as well as careful consideration as to how it is working after it has been put into effect. Not infrequently it has been found that what looked good on paper failed in practice. These weaknesses must be detected and remedied if the confidence and co-operation of the operating force is to be had; without this, no matter how well thought out, any system is destined to failure. A well worked out system of inspection and maintenance of power-plant equipment not only reduces the cost of repairs and prevents costly shutdowns, but also may make it possible to reduce the amount of reserve capacity necessary to insure continuity of service, which is only another way of saying that it increases the service factor of the equipment and reduces the cost of installation per kilowatt output.

High Tension a Minor Source of Accident

IT SOMETIMES happens that some appliance or force gets such a reputation for danger that it actually becomes relatively safe because all who deal with it observe every possible safety precaution. High-tension alternating current, at least in the large modern generating station, is practically in that class. Records kept at the Waterside Station of the New York Edison Co. show that out of 243 accidents during the year 1921, only 14 (6 per cent) were due to all operating causes, including electrical. Shop and repair work claims 62 per cent and coal and ash handling the remaining 32 per cent.

These facts, which were brought out by E. M. Van Norden in a recent talk before the American Society of Safety Engineers, are significant. They show that engineers should give increased attention to the hazards

of men engaged in repair work and in the handling of coal and ashes. With regard to the latter much can be learned from the new Hell Gate Station of the United Electric Light and Power Company. The coal-handling hazards have been greatly reduced there, and those of ash handling—thanks to the hydraulic ash-removal system—have been practically eliminated.

Accuracy in Data Books and Handbooks

RECENTLY, a prominent concern was revising the little data book which it issues gratuitously to its customers. In the course of the work it occurred to someone in the organization that it would be desirable to have some of the tables of equivalents checked up carefully. Therefore, these tables were sent to the National Bureau of Standards in Washington for verification. The result certainly must have been a surprise to the editor.

The first tables examined were those of equivalents of metric and English units. On the first page, out of about twenty sets of equivalents only two were correct. What was found in later pages where more complicated data were given, has not been revealed. It is to be feared that many data books are in an equally unfortunate condition. Certainly, if one undertakes to compare the figures in the various books and pamphlets that come to an engineer from time to time giving what are supposed to be "standard figures," startling discrepancies are found.

There is no excuse for the issuance of carelessly prepared or inaccurate tables of engineering data. Moreover, their issuance works a hardship upon those to whom the tables go and fails utterly to serve the purpose of those who prepare and issue the tables. The Bureau of Standards in Washington stands ready at any time to assist authors or prospective authors by correction of tables of data in accordance with the latest available figures that are on record at the Bureau. This does not by any means imply that the Bureau will go over endless sheets of tabulation or start extended researches for the verification of figures prepared haphazard. It does mean, however, that the Bureau will co-operate with any responsible company or individual that is sincerely attempting to prepare reliable figures on physical or engineering subjects within the scope of the Bureau's activities.

In many cases engineering and technical manufacturing companies have available data far more significant and reliable with respect to special topics than are usually found even in standard handbooks. In such cases it is, of course, futile for the company to submit such data to anyone else for verification. The only thing essential is to insure that in preparing the table the greatest care has been exercised to eliminate errors, to make the tables clear and comprehensive and to insure that mistakes do not creep in through faulty typesetting or proofreading. However, the case is quite different when tables of standard units are involved.

The object of special data books is advertising for the producer and convenience for the user of the materials advertised. When carefully prepared, such data books are a great convenience and a legitimate method of publicity. In fact, one of the very highest orders of technical advertising may be achieved through such means properly used. On the other hand, if the work is not carefully and accurately done, the result is anything but helpful. The potential benefit to the producer is lost and when discrepancy in the work is discovered, the customer may become not only disgusted with the tables, but also suspicious of the reliability of the concern that issued them. It is certainly to be hoped that the engineers will not be compelled indefinitely to look with suspicion upon tables of data simply because they have the trade mark or name of some commercial concern printed on their cover.

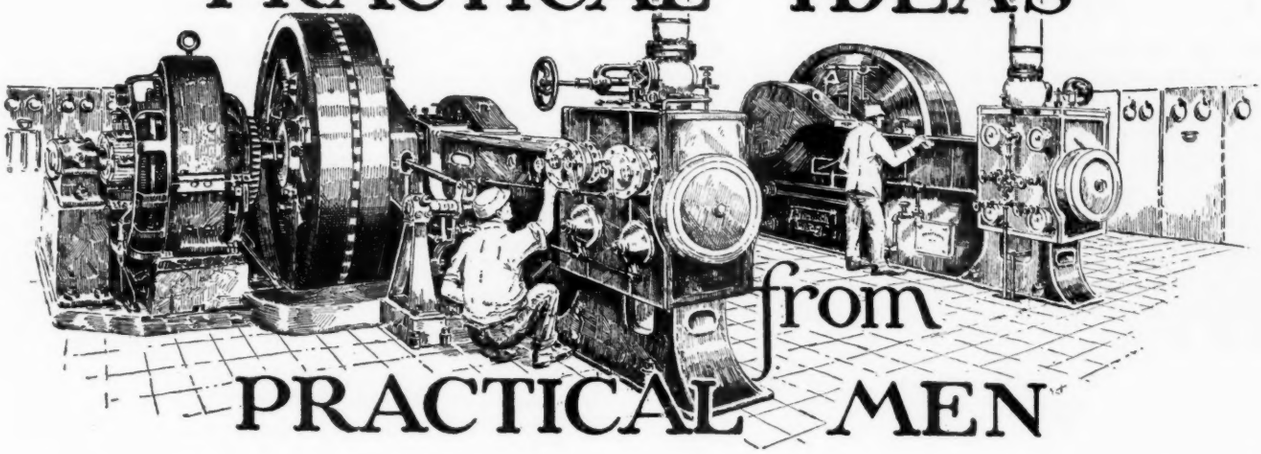
Several years ago a few of our universities adopted six years as the requirement for an engineering degree. This has not been altogether popular. Now the deans of fourteen universities in the Middle West have agreed to urge the adoption of five-year engineering courses in order to permit more time in the first four years to humanistic and fundamental subjects in place of advanced technical work which will be taken up in the fifth year. This apparently is aimed to meet the demand of the industries for engineering graduates broadly trained in fundamentals and thus fitted to take up specialization within the various branches of the industry rather than attempt this within the university.

As long as coal was cheap little or no attention was given to keeping records of steam-plant operation, but as the cost of fuel increased it began to be realized that large savings could be made in the expense of operating the plant by a better understanding of its operation at all times. From this has developed the practice that is followed in many of the large stations of keeping records of station operation and running the plant under practically test conditions at all times. These practices, which have proved so efficient in steam-plant operation, can be well applied, in modified form, to many hydroelectric plants that run in parallel with steam stations. There are many ways of operating these plants, but there is only one that will produce the greatest number of kilowatt-hours from the available water, and this can be determined only by keeping careful record of stream flow and plant operation and making an intelligent analysis of these records.

Surround a thing with an air of mystery and it immediately takes on added importance. Such appears to be the case with the North Tees Station in England, the management of which has not only consistently refused to give out information concerning its design or operation, but has been particularly averse to allowing American engineers within its walls. The natural inference has been that there was something to hide. The station is not a large one as plants go in this country, there being only two fifteen-thousand kilowatt machines, but high pressures and temperatures are employed, also stage reheating in the turbines. The latter refinement necessitates a very long turbine shaft and herein, it is reported on good authority, lies the bogy.

Waste heat, which is an economic loss the year round, becomes a positive nuisance in the summer time. It is hard to see why anybody should pay out good money to be uncomfortable, yet this is being done in hundreds of power plants all over the country. The bare steam pipes that waste coal and "superheat" the boiler room can easily be covered and at small expense. The sensible thing to do is to finish the job before hot weather.

PRACTICAL IDEAS from PRACTICAL MEN



Care of Recording Instruments

One of the duties that now falls to the lot of the engineer is the care of recording instruments. Unfortunately, a great many engineers do not take the interest in these instruments that they should. It is very common to find valuable recorders out of order, and in many cases no one seems to have any interest in keeping them in operation.

Some time ago I was employed in a fair-sized plant where no records were kept and no recording instruments were provided. The only time the superintendent visited the power plant was when he had something to kick about, and his visits generally ended by someone being laid off, as he considered most of the trouble that occurred in the mill to be caused by low steam pressure. If a machine in the mill lay down on the job owing to a belt slipping or some mechanical defect, the whole trouble, according to the superintendent and the foreman, was low steam. If the help went home at night and left all the windows open and could not work in the morning because the plant was too cold, that was caused by the steam being down at night, and as there was nothing to show that the steam had been kept up, the power plant took the blame.

As this sort of condition can exist only for a certain length of time, this was no exception, and a new superintendent took charge of the plant.

One of the details of this particular business was the supplying of steam to a kiln room. The second day the new superintendent was on the job, the man in charge of these dryers forgot to turn the steam on them before going home. This caused a loss of about $300. Next day the superintendent took this matter up personally, and he was informed that the steam had been shut off at the boiler room. Unfortunately, the engine-room staff had nothing to show to contradict the statement, so the superintendent immediately gave orders for a complete installation of recording instruments.

Every main steam pipe throughout the plant was fitted with pressure recorders. In the boiler room steam-flow meters and CO_2 recorders were installed, also recording thermometers wherever necessary to give information on the operation of the plant. The superintendent posted a notice asking the men to make any suggestions that they might have for further improvements. One suggestion was that a man with a good knowledge of mathematics and lots of common sense be employed to look after this equipment and have full responsibility of the care and upkeep of the instruments, as well as the records and supplies. This suggestion was adopted, with excellent results.

Personally, I believe that much of the prejudice shown against these instruments is caused by trying to put the care of the machines up to the plant operators. The general run of firemen seem to consider that records are simply a check upon their work, and therefore they are not interested in the recording devices in any way.

If a chief engineer has the ability to get his men interested in the equipment and its operation, he will have the right men for the job, but it is a regrettable fact that a great many chiefs are not interested in educating their men in any way—"a thankless job," they say and a lot of them actually believe that.

To illustrate this point, an engineer once visited a plant where there were five firemen, each handling three boilers. The boilers were all equipped with steam-flow meters, and at the time of his visit these meters had all been out of service for some time. As his company was interested in the operation of the plant, he asked the chief just why the meters were out of service, and his statement was as follows: "Nobody in the boiler room has brains enough to keep them in order and I have not got the time," although he had just spent two hours sitting in his office telling funny stories. The engineer asked the chief's permission to have a little talk with the firemen, which he gave him with a laugh about the time he was going to waste. However, he went to the boiler room and asked for the best fireman. They immediately asked how he would determine who was the best fireman. He replied the man that can get the most steam out of the boilers at the least cost, and explained to them that if the meters were in service they could tell at a glance just what each boiler was doing, and as the coal was weighed for each boiler they could make a game out of their jobs by seeing who could get the best record.

A month later he visited the plant again and every flow meter was in service and looked like a new machine. His little talk the month before had raised their enthusiasm and he had accomplished something that the chief frankly admitted was too big for him. He then gave the men instruction on the methods of obtaining data from the chart; namely, the area of the

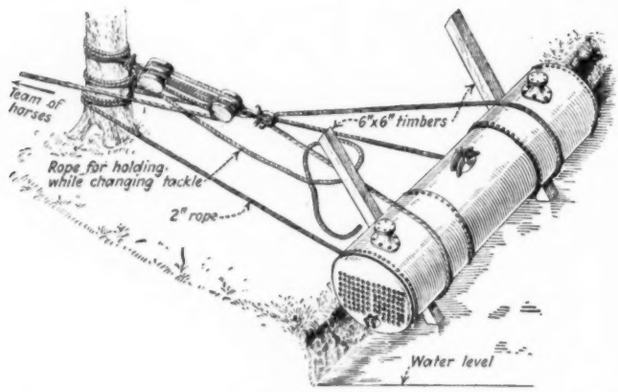
chart, the total steam generated in pounds, the evaporation per pound of fuel and the rating.

However, I am of the opinion that if accurate records are desired and instruments are to be kept in the best operating condition, a man should be assigned to this work who is interested in this particular line and is enthusiastic about steam-plant efficiency.

Fall River, Mass. ARTHUR D. PALMER.

Delivering a Sawmill Boiler

A horizontal tubular boiler for a lumber mill in Maine had been brought from Boston by schooner, but owing to shoal water in the creek, the vessel was unable to get nearer than one-half mile of the mill. As no



SHOWS METHOD OF HOISTING BOILER ONTO THE BANK

scow was available, the manhole and handhole plates were put on, and the other openings were plugged, after which the boiler was put overboard and towed by gasoline launch to a point near the mill, where a large tree grew about fifteen feet from the bank. At this point the water in the creek was three feet below the ground level.

With tackle borrowed from the schooner, the boiler was hoisted to the bank, as shown in the cut. The bight of a 2-in. rope was made fast to the tree and a turn taken around the boiler halfway between the manhole in the center, and each end. The ends of the rope were then hitched to a four-fold tackle attached to the tree. An extra rope was provided, to hold the boiler while changing the tackle. Two 6 x 6-in. timbers were placed against the bank, and as the boiler came over the edge, the timbers tipped inshore and served to hold the boiler off the ground, while the skids and rolls were put under it. M. M. BROWN.

Camden, Me.

Wooden Condenser for Reclaiming Exhaust Steam

Occasions frequently arise in industrial plants of the older and less modern class, when the adoption of standard and modern engineering practice in choosing the material and design for new or proposed changes in equipment is discarded for more primitive material and methods.

Such a case confronted the writer when he had charge of the engineering department of a pulp and paper mill, and led to the unusual idea of adopting wood for the material of a condenser and heater.

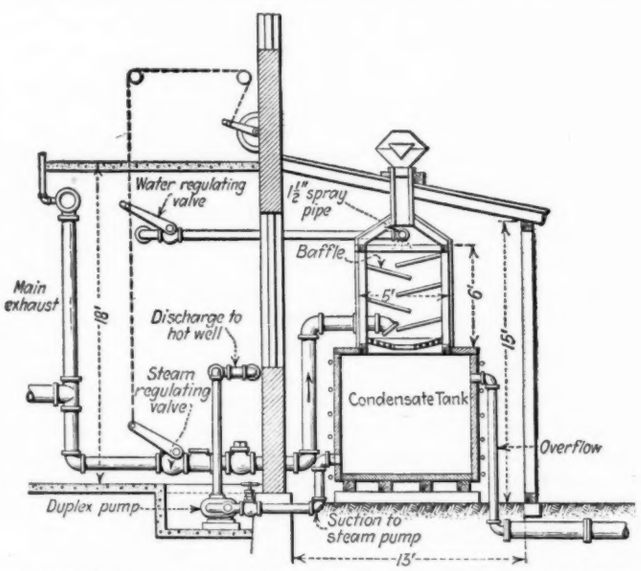
The steam wasted in the various departments of the plant was observed for some time, and it was finally decided to adopt a condenser or heater constructed of wood staves, as shown in the illustration, which afterward proved to be desirable on account of initial cost and early results.

Originally, saturated steam of 160 lb. pressure was supplied to drive a 425-hp. steam turbine and the exhaust was used on the dryers of the paper machines and then allowed to escape to the atmosphere. Only the drip or condensate from the dryers was returned to the boiler room.

To eliminate this waste of steam, a wooden tank 8 ft. in diameter and 7 ft. high was installed outside the building wall and on top of this tank was built a compartment 5 ft. square and 6 ft. high, containing a number of perforated wooden baffles with a 2-in. partition at the bottom perforated with 1-in. holes spaced 2 in. on centers and slightly pitched toward the center, with an opening 8 in. square in the center for the admission of the exhaust steam.

The steam enters through an 8-in. pipe at the bottom of the baffle chamber at an angle of 45 deg. and then comes in contact with the water in the tank, which is kept about two-thirds full, and is also condensed by cold water flowing over the baffles. The water is admitted through a 1½-in. spray pipe at the top of the chamber; any excess steam finally escapes to the atmosphere.

The regulating valves of the condensing water and the exhaust steam are attached to a common lever which is operated from the main floor. This controls the quantity as well as the temperature of the con-



CONDENSER AND HEATER MADE OF WOODEN STAVES

densate by admitting a corresponding amount of cold water for a given opening of the exhaust-steam valve.

An overflow is provided near the top of condensate tank, and the discharge from the bottom of the tank is connected to a duplex pump which returns the condensate, usually at about 150 deg. F., to the hotwell, from which it is pumped to the boiler.

This condenser has been in operation for some months and has given good results, while a saving of 6 to 8 per cent in the fuel bill has been obtained.

Gardiner, Me. P. H. HERREN.

Not So Much Efficiency as He Thinks

Can a 300-hp. synchronous motor driving a 200-kw. direct-current generator set be operated on wattless current? The motor operates on 2,200 volts and the generators supplies 275-volt current. The fields of the motor are excited from the generator. The load on this set for the past year has been two six-ton locomotives and the average load is about 25 kw. When both locomotives happen to start at the same time, the ammeter will show about 400 amperes on the generator for a few minutes. About half of the time the generator is running without load. We average the kilowatts recorded on the wattmeter for each month by dividing the kilowatts by the number of hours run. It ranged from 28 to 73 kw. per hour. The voltage of the supply circuit is very irregular. With no load on the generator I have seen the wattmeter disk make 5 r.p.m. This means 36 kw.-hr. to pay for and the demand meter swings up to 35 and 40.

On the motor-field rheostat there are six plates in multiple. I cut one out and reduced the amperes in the field to 12 and then another and reduced it to 10. Now, with 250 volts on the generator and 10 amperes in the motor field, I am getting some efficiency. I reasoned that if an overexcited field made the wattmeter travel too fast, an underexcited field would make it travel backward. I reduced the field amperes to 10 when the voltmeter showed 250, and the wattmeter came to a standstill with no load on the generator. I do not know how much load the generator will carry with this field excitation on the motor, but the ammeter has gone up to 400 amperes many times. When the potential drops on the 2,200-volt line, the wattmeter goes backward when there is no load on the generator.

What kind of a current do you call it when the wattmeter goes backward? It is wattless enough for the man that has to pay the bills. I have seen it make as much as 1 r.p.m. backward. The set is certainly working fine; the motor runs much cooler than when it was overexcited as I suspect that the excess current we were paying for was heating the motor.

The four plates on the motor-field rheostat are all in, and if I wanted to carry 275 volts on the generator, I would have to cut out another plate to get sufficient resistance. We nave been running this set about two months along these lines, and there is quite a difference between paying for 50 to 72 kw. per hr. and 30 to 40 demand, and 23 kw. per hour and 10 to 15 demand for the same work.

It is interesting to watch the wattmeter disc. With no load on the set it creeps backward and forward, showing the slightest variation in the speed of the motor; it is seldom at rest. Sometimes the motorman will close the controller on the locomotive for a second to move a short distance to couple cars or switch, and the disc responds beautifully, making a fraction of a revolution and coming to rest again.

This set can be run all day with a load of 4 or 5 kw. on the generator and the wattmeter stationary or creeping backward. The wattmeter has been tested, and it showed 1.6 per cent fast. The meter is of the polyphase type, rated at 50 amperes, with current transformers having a ratio of 10 to 1 and potential transformers having a ratio of 20 to 1, and is connected on a 60-cycle circuit.

A. H. HALLADAY.

Spring Valley, Ill.

[Although the author of the foregoing letter is somewhat mixed up on what he is accomplishing in the operation of the motor-generator set, he has raised an interesting question as to why the wattmeter acts as it does. The letter was submitted to Victor H. Todd, and the following is his reply.—Editor.]

In analyzing a problem of this nature, it is well to determine first the electrical conditions produced by the methods of operation described and then to consider the effect of these conditions on the electric motors. The generator is run by a synchronous motor, and from the heating described, the motor has been running with an overexcited field. Overexciting the fields of the motor will cause it to have a leading power factor. When the load comes on, the armature reaction causes a weakening of the field and therefore a power factor tending to lag. Weakening the field by means of the field rheostat also causes the power factor to lag, decreases the I^2R loss in the field windings and reduces heating.

It has been proved repeatedly that a correctly connected polyphase watt-hour meter will record the true energy in watt-hours consumed by the apparatus described. There are many incorrect connections which may give positive or negative registration, dependent on the connections and the load; some of the connections may give almost correct registration at certain loads and power factor and absolutely valueless indications with the same connections at other loads and power factors, and one of these wrong connections will undoubtedly account for the incorrect registration.

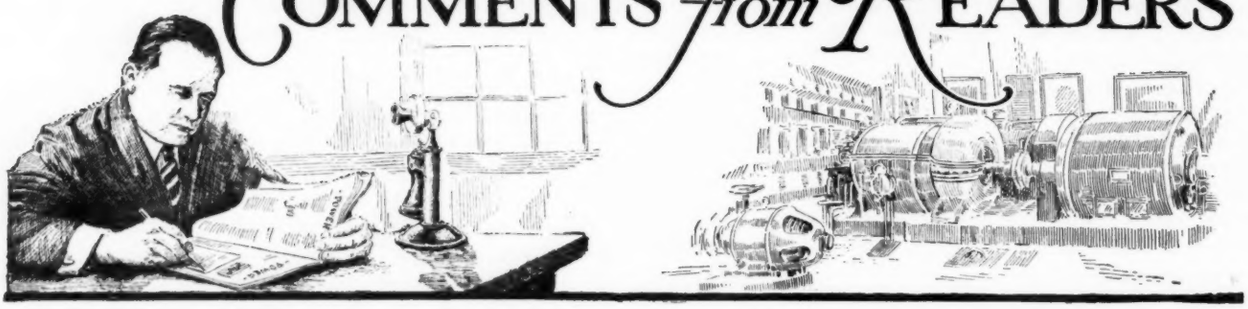
In a correctly connected polyphase watt-hour meter, when the load has 100 per cent power factor, there is a normal phase displacement of 30 deg. between the current and potential in the meter elements. When connected to a three-phase circuit, the current leads in one element and lags in the other, but both elements give equal positive registration which total to the actual load on the apparatus. Taking this correctly connected watt-hour meter and reverse either the shunt or series winding of the element in which the current is leading, and the torque of this element is now negative, but since it is balanced by an equal and opposite torque from the other element, the registration is zero. This condition prevails at all loads so long as the power factor remains 100 per cent. But should the motor's field strength be changed either by armature reaction or field resistance, it is possible to make the watt-hour meter rotate forward or backward, because at power factors other than 100 per cent the torque of one element is increased and the other is decreased.

It would appear, however, that although this shows how the rotation may be reversed, it does not cover the entire action, as described; but vector diagrams may be laid out if sufficient time and patience be available, to determine the action under the other incorrect connections until one is found which meets all conditions.

If the connections are correctly made, it will be found that the watt-hour meter will record the true watts, and that a new form of perpetual motion, or getting something for nothing, has not been discovered by running a motor on "wattless current." Various estimates claim that there are from 6 to 10 per cent of all the polyphase watt-hour meters in the United States connected wrong and giving incorrect registration.

Summit, N. J. VICTOR H. TODD.

COMMENTS from READERS



Why Not Use a Slide Rule?

I have been interested in the comments on the use of the slide rule in answer to the editorial in the April 18 issue of *Power*. As a practical user of slide rules for various branches of engineering, I beg to verify W. L. Durand's statement in the May 2 issue.

I have three slide rules of lengths 8, 10 and 18 in. The 8-in. rule I use for electric work alone, while the 10-in. polyphase rule will apply to almost any problem around the plant. I use the 18-in. rule in problems involving heavy multiplication and division.

Every engineer should learn slide-rule operation. A little daily practice will enable him to go over his plant and know what the operating conditions are in a very short time. The slide rule takes up less space in the pocket than a handbook of tables and is a wonderful time saver. V. K. STANLEY.

Ponca City, Okla.

Water-Column Valves

In the article in the April 11 issue on the subject of valves in the water-column connections, no mention is made of the one outstanding reason why the valves between the water column and boiler should be eliminated.

One instance is given where a quantity of paper stock was saved by the prompt closing of these valves when the drain pipe was broken on the bottom of the column. Losses of this nature can be covered by insurance, but no insurance can protect the innocent public from injury or death caused by boiler explosions that may result from these valves being left closed.

It is evident that many engineers place convenience before safety, and for that reason Mr. Carkill misrepresents the old slogan when he says "safety first" in his opinion calls for a valve in each connection.

It is not fair to compare the shutoff on a water glass with valves placed between the column and boiler when the gage cocks are on the column, because it is the cocks that show the true level and should be used when the level in the glass is in doubt. In my opinion no human controlled apparatus should be placed in these connections that would interfere with the true indication of water level at any time R. G. SPOONER.

New Bedford, Mass.

Some of the points brought out in favor of these valves such as preventing a shutdown of the boiler, would apply only in the cases mentioned; but what if the connecting nipples had broken off between the valve and the boiler?

A valve in the water column also provides a place for sediment and scale to collect and may cause the pipe to become plugged. If it is a globe valve, it prevents cleaning of the connection without breaking joints. A valve in my opinion is not only objectionable, but is too handy and might be accidentally closed by some irresponsible person, unless it is locked open.

I know of a case where an engineer had a globe valve installed in the connection and the disc became free of the stem and closed the opening, and had it not been for the fireman trying the drain before it was too late, an explosion might have been the result.

In preference to installing a valve in the connection, I would place a guard around the connection to prevent anything from striking the pipe and breaking it off. When a valve is installed, it should be of the straight-way cock type, and should be arranged for locking open. C. W. CARTER.

Olean, N. Y.

Bending Large Conduits

I noticed in the letter from H. A. Geis, in the April 11 issue, that he frequently reads the advice to fill electrical conduits 2 in. and over with sand and heat before bending. He also describes the troubles liable to occur if this method is followed.

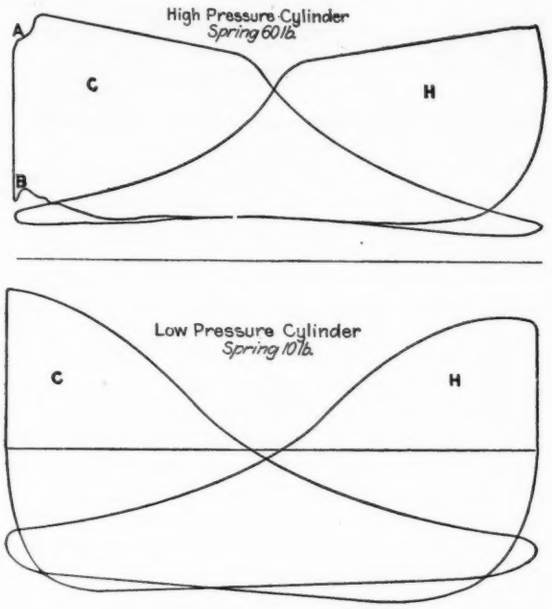
Personally, I have never seen this advice printed in any technical magazine which suggested its use with any except ordinary iron pipe when making short bends. I have frequently used this method with excellent results, but care is necessary to avoid flattening or distorting the pipe. Bends can be made on conduits 2 in. or larger, by packing the pipe solidly with clean dry sand and firmly plugging both ends. No heat is necessary, and no kinks or flattening will occur if care is taken when doing the work. On iron pipe short bends invariably break in the making when attempting to do it cold.

I have never seen a good short bend made on conduit or pipe 2 in. or larger when the pipe was empty and bent cold, but long bends can be made without trouble. Common sense usually directs the average workman when bending pipe in a machine, and if no machine is available he will generally place the end of the pipe between timbers, or in other suitable location, avoiding sharp corners on iron beams, etc. I question if sand grains will embed themselves into galvanized coating on a cold pipe while bending it. A short bend can be made by filling such pipes with melted rosin or lead, but this necessitates heat being applied to get the filling out after the bend is completed.

Toronto, Ont., Canada. JAMES E. NOBLE.

Indicator Diagrams for Criticism

With reference to Mr. Spugg's article on indicator diagrams for criticism in the April 18 issue, in the high-pressure diagram *C* the drop in the compression line at *B* is due to a leaky exhaust valve. This may be caused by the valve riding on shoulders or overtraveling.



DIAGRAMS FROM COMPOUND CORLISS ENGINE

This leak not only causes low compression but also prevents the admission pressure from rising to the initial pressure. This causes the curve in the steam line at *A*. The sloping steam line is caused by the steam valve not opening sufficiently. This is possibly the result of wear and lost motion on the valve gear. The round corner at the point of cutoff is due entirely to the worn condition of the tripping cam and tail plate on the latch.

On the Diagram *H* the compression is excessive and the steam admission is late. This is probably due to wear on the bushings and lost motion between the latch and block.

Both diagrams show a cutoff at more than two-fifths stroke, and with a single eccentric operating all four valves it would be difficult to make much change in the adjustment of the exhaust valves without some effect on the steam valves. The low-pressure diagrams show that the exhaust valves do not open early enough and the port opening is restricted. This causes the back-pressure line to slope gradually as shown.

Comparing the point of cutoff of the two diagrams, it appears that the low-pressure cylinder is not doing its share of the work, while the high-pressure is carrying practically full load. The receiver pressure is not given, but since a No. 10 spring is used, this would be about 18 lb. Shortening the cutoff on the low-pressure side, thus increasing the receiver pressure to about 23 lb., would cause the low-pressure cylinder to take more load and more evenly divide the load on the engine.

Cambridge, Mass. R. A. CULTRA.

The high-pressure diagram *H* shows late admission, and on the diagram *C* the compression seems to cease at *B*. The latter may be caused by the exhaust valve rising from its seat or overtraveling the port. The curve at *A* is due to late admission and may be caused by incorrect adjustment of eccentric or reach rod.

The low-pressure diagrams both show late release. This is probably due to faulty adjustment of the valve gear. If the engine is single eccentric, it may be difficult to overcome, as the valve adjustment on this class of engine is limited. H. R. ROCKWELL.

Bogalusa, La.

Method of Tagging Valves

There have been a number of articles in recent issues of *Power* in regard to the tagging of valves in pipe systems. Aside from the question of the methods mentioned being used for records of work done, it does not seem to me that the greatest degree of safety is obtained by simply tagging. The tags may be lost or overlooked, or the valves opened by irresponsible persons.

In my opinion a better way in cases where accidents might occur is to fasten an iron bracket to the bonnet of the valve and lock the valve wheel to it with a padlock. This has been used to my knowledge in the case of stop valves on boilers that were being cleaned or repaired, and where the workmen had to go inside the boilers. It is also an excellent method of preventing the accidental closing of electric switches. The essential feature of it is that the key to the padlock is held by the man doing the work. S. W. MILLER.

Rochester, N. Y.

Installation of Metal Conduit

In the article by Mr. Hefner on the installation of metal conduit in the April 4 issue, he claims that saddling a beam by bending conduit cannot be done neatly and is difficult to support rigidly, and he shows

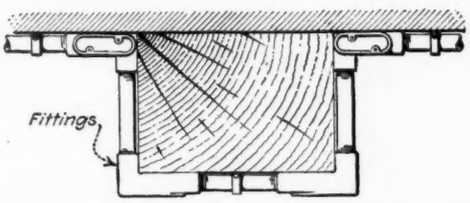


FIG. 1. A NEAT METHOD OF SADDLING A BEAM

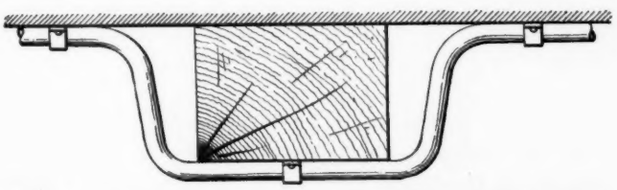


FIG. 2. SADDLING A BEAM BY BENDING THE CONDUIT

in Fig. 10 (Fig. 1 herewith) a better way of doing this by using condulets.

In Fig. 2 is shown the method I used in installing conduit which saddled beams 12 x 12 in., spaced 8 ft. apart. As the cost of material was a big consideration, the method shown in Fig. 1 was considered prohibitive, because it required four condulets to each beam. By bending the conduit as here shown, it was rigidly supported at each beam. G. W. BRUSH.

Citronelle, Ala.

QUESTIONS AND ANSWERS

Sampling and Analysis of Oil in Circulatory System

If samples of lubricating oil are taken from the circulatory systems of a power plant, what sort of an analysis should be made and what physical or chemical properties should be compared? W. L. M.

At least one quart of samples should be taken and analyzed for the following properties: Per cent water, per cent sediment, character of sediment, metal, carbon, earthy material, rust, metallic salts, etc., per cent emulsion, viscosity, acidity, flash point and rate of separation from water. A comparison of these properties on a number of consecutive samples will give a good idea as to whether the oil is in proper condition and whether it is standing up as well as it should.

Water Cooled per Ton of Refrigerating Capacity

How many gallons of water can be cooled per hour from 75 deg. F. to 55 deg. F. per ton of refrigerating capacity? W. M. T.

The commercial unit of capacity of a refrigerating machine is taken as the abstraction of an amount of heat equal to the heat of fusion of 1 ton (2,000 lb.) of ice per day (24 hours). The average heat of fusion is about 143.33 B.t.u. per lb., which is equivalent to 286,660 B.t.u. per ton, or the taking up of heat in a machine of unit capacity at the rate of 199.07 B.t.u. per min. This is so close to the convenient round figures of 200 B.t.u. per min. = 12,000 B.t.u. per hour, that these figures are always used for commercial rating of refrigerating capacity.

For cooling water from 75 deg. F. to 55 deg. F., each pound of water would require the removal of 75 — 55 = 20 B.t.u., and a ton of refrigerating capacity would cool 12,000 ÷ 20 = 600 lb. of water an hour, and allowing $8\frac{1}{3}$ lb. of water per gallon, there would be 600 ÷ 8.33 = 72 gal. cooled per hour.

Point of Cutoff if Valve Fails To Unhook

In a single-eccentric Corliss engine, if there is not release of the cutoff owing to overload or other cause, will not the point of cutoff depend on the amount of lap and position of the eccentric, or will the steam be admitted during the full stroke? P. S. W.

A complete swing of the wristplate from the central position to one side or the other and return to the central position is accomplished by revolution of the eccentric and crank through 180 deg., or one-half of a complete revolution. With any lap on the valve when the wristplate is in central position, the valve cannot begin to open until the wristplate has passed beyond the central position; and as the valve is again closed after the wristplate has swung over to the extreme position and returned to the position where the valve began to open, it follows that when the valve has lap it will not be held open during as much as 180 deg. revolution of the crank and eccentric. Therefore, if the valve has lap and the eccentric is so set that the valve is opened as early or earlier than the beginning of the stroke, the valve would be closed before the very end of the stroke, because for a full stroke there would be 180 deg. revolution of the crank. However, the eccentric may be set backward to open the steam valve so late after the beginning of the stroke that the period during which the valve remains open may extend to the end of the stroke; but with a single-eccentric Corliss engine, that would be impractical, because setting the eccentric backward would delay the opening and closing of the exhaust valves.

Reduction of Safe Working Pressure for Broken Staybolt

If one staybolt in the water leg of a locomotive-type boiler is broken, how much should the pressure be reduced? N. M. K.

The maximum allowable pressure for stayed flat plates with staybolts of uniform diameter and symmetrically spaced, for new constructions covered by a factor of safety of 5, is given by the formula,

$$P = C \times \frac{t^2}{p^2}$$

where P equals maximum allowable working pressure in pounds per square inch, t is the thickness of plate in sixteenths of an inch; p the maximum pitch of staybolts in inches measured between straight lines passing through the centers of staybolts in the different rows, which lines may be horizontal, vertical or inclined, and C is a constant to be taken as 112 for stays screwed through plates not over $\frac{7}{16}$ in. thick with ends riveted over or 120 when plates are over $\frac{7}{16}$ in. thick.

For determining the effect of a broken staybolt, the value of p in the formula would be taken as though the defective staybolt had been omitted from the construction. If the straight lines passing through the centers of the staybolts in different rows are at right angles to each other and equally spaced, the neglect of one stay would make the dependable pitch twice as much as the original pitch; and as per the formula the allowable working pressure is inversely as the square of the pitch, then with a broken staybolt the safe working pressure for the plate would be $\frac{1}{2^2}$ or $\frac{1}{4}$ as much as before the staybolt was broken, although with that much reduction of the former working pressure the load on the remaining staybolts would be reduced.

Form of Telescopic Valve

What is a telescopic engine valve, and what is the urpose of making a valve of that form? W. H.

The term telescopic is applied to a valve made in two rincipal parts, each consisting of a slide valve, one art telescoping inside of the other so they will be read apart by the steam pressure for holding opposite aces against their seats to make the valve steamtight.

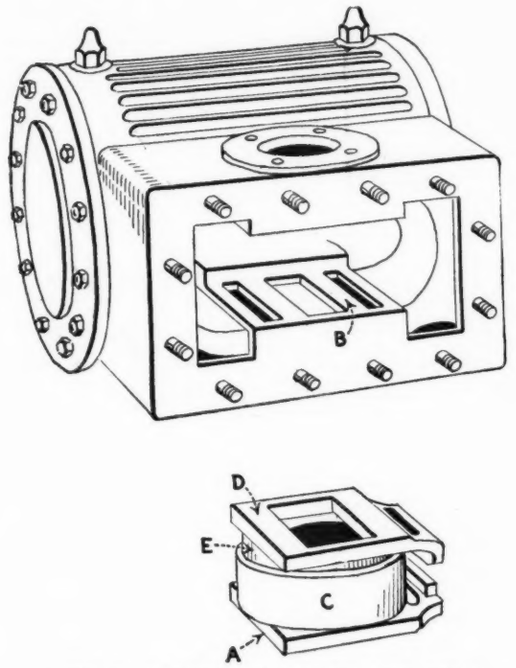


FIG. 1. TELESCOPIC VALVE AND SEAT

A form of central admission telescopic valve and one of the seats *B* is shown in Fig. 1, and a sectional view of the valve and opposite seats is shown in Fig. 2. In the figures the same letters refer to corresponding parts. The lower portion of the valve consists of a slide valve *A* riding on the seat *B* and provided with a

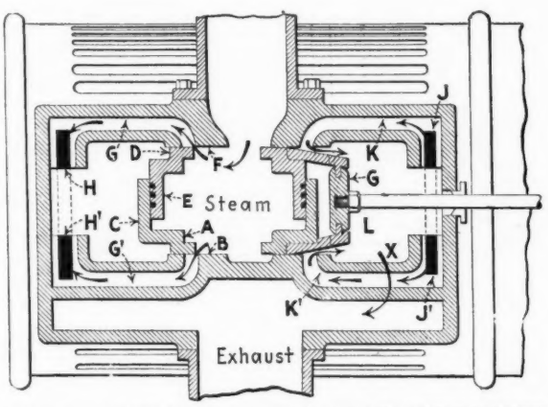


FIG. 2. SECTIONAL VIEW OF TELESCOPIC VALVE

cylindrical shell *C*. The upper portion consists of a slide valve *D* with a cylindrical shell *E* that telescopes inside of the cylindrical shell *C*. Steam pressure holds the part *A* to the seat *B* and the part *D* to its seat *F*, shown in the sectional view, Fig. 2.

The valve stem is held by a screw thread and nut to a T-headed piece *G* into which the upper and lower parts are tongued so the parts may change their relative positions without affecting the alignment of the valve stem.

As the valve that is illustrated takes steam from the center and exhausts on the ends, it moves toward the end of the cylinder to which steam is admitted. Fig. 2 shows admission taking place through ports to passages *G* and *G'* and cylinder ports *H* and *H'* to the head end of the cylinder, while exhaust is taking place out of cylinder ports *J* and *J'* in the crank end through passages *K* and *K'* to the exhaust chamber *L* from which, as indicated by the arrow *X*, the exhaust is conveyed through another passage to the exhaust pipe.

The leading purpose of the double-seated central-admission form of the valve is to obtain less valve area subject to unbalanced pressure, and the telescopic form is adopted so the unbalanced pressure may hold both section of the valve tight to their seats and follow up any wear.

Motor Running Above Speed

A 30-hp. 115-volt interpole motor designed to operate at 1,700 r.p.m. is used to drive a centrifugal pump. When first started, it runs at 1,530 r.p.m. and takes about 150 amperes; as the temperature of the machine increases, the speed increases until the motor is operating at 1,770 r.p.m. and takes 225 amperes. The temperature rise does not exceed 30 deg. C., and the voltage remains practically constant. Normal full-load current of the motor is 220 amperes. What is the cause of this increase in speed, and what may be done to remedy the difficulty? F. E. C.

The speed of any direct-current motor will be higher after the field coils have had an opportunity to heat up. This increase in speed is due to the resistance of the field coils increasing with the temperature, which reduces the field current. However, this increase should be only about 5 per cent, where with the motor in question the increase is 15.6 per cent with the load increasing 50 per cent. If the load had remained constant, the increase in speed would have been about 20 per cent. such an increase in speed is excessive for a normal motor and is probably caused by the brushes being located in the wrong position on the commutator or the interpole field being too strong, or to a combination of both. Shifting the brushes back of the neutral on an interpole motor will tend to cause its speed to increase as the load increases. If the interpole field is too strong, it will also have the same effect. The remedy in the first case is to locate the brushes properly on the commutator. To do this, the coupling between the pump and motor may be opened and the speed of the motor taken. Then the motor is reversed and the speed taken again. If the brushes are in the proper position the speed should be the same in either direction. If this condition does not exist, then adjust the brushes to where the speed is the same for either direction of rotation. If the interpole field is too strong, this can be corrected by connecting a shunt of the proper value across the interpole-winding terminals.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Strength of Electrically Welded Pressure Containers*

By R. J. ROARK
Assistant Professor of Mechanics, University of Wisconsin

THIS investigation was made by the writer for the Vilter Manufacturing Co., of Milwaukee, who furnished all test specimens. The tests on the specimens cut from the containers and on the specially prepared specimens were made in the Materials Testing Laboratory of the University of Wisconsin.

The primary purpose of this investigation was to demonstrate the strength and uniformity of a certain type of commercial pressure container with electrically welded head joints. These containers were made of lap-welded pipe and were provided with spherical flanged heads. Their dimensions are given in Fig. 1. The average physical and chemical properties of the steel used, as reported by the company furnishing it, were as follows: Yield point, 38,000; ultimate, 64,000; elongation, 27 per cent; carbon, 0.17 per cent; manganese, 0.44 per cent; phosphorus, 0.01 per cent; sulphur, 0.027 per cent. It was proposed to determine the absolute strength of such containers by pressure tests on representative samples and to establish a comparison with vessels of like form and dimensions, but with gas-welded and riveted heads, by similar tests on such containers. In order to secure a more positive check on the uniformity of the joints and more specific information as to their strength under various conditions of stress, it was planned to cut from the containers specimens of such form as to give, when subjected to laboratory tests, the desired information. Partly to determine the best form for such specimens and the best method of testing them, and partly to aid in the interpretation of results, strain measurements were made on certain of the specimens during the tests. From these measurements relations were established between the internal pressure in a vessel of the standard type and the resulting stresses on the head joint.

In all, nine containers were tested. In each case the test consisted of subjecting the specimen to an internal hydraulic pressure which was gradually increased until rupture resulted or such rapid leakage developed as to make further increase of pressure impracticable. Pressure was in most cases applied in predetermined increments by a hand pump and was measured by an indicating gage that had been calibrated immediately before its use in these tests.

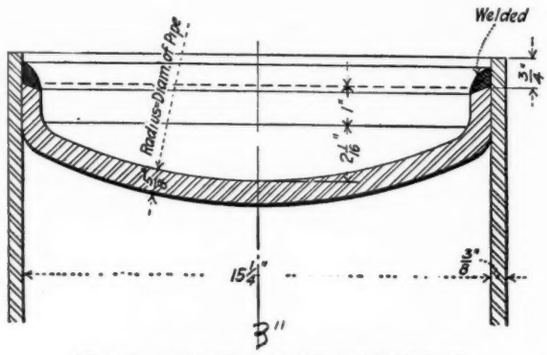


FIG. 1. SHAPE AND DIMENSIONS OF SPECIMEN CONTAINERS

Some of the specimens were of standard design. Some were so made as to secure failure of a particular sort in order to provide information on some specific point. In

*Excerpts from paper before the Spring Meeting of the A. S. M. E. at Atlanta, May 8-11.

RESULTS OF PRESSURE TEST ON CONTAINERS

Specimen Number	Description of Specimen	Pressure in Lb. per Sq. In. at: First observed Leakage	Dishing of Heads	Maximum	Method of Failure	Stresses on Head Joint at Maximum Pressure: Longitudinal Shear, Lb. per Linear Inch of Joint	Radial Tension, Lb. per Linear Inch of Joint	Bending Moment Inch-lb. per Linear Inch of Joint	Max. Resultant Shearing Stress, Lb. per Sq. In.	Max. Resultant Tensile Stress, Lb. per Sq. In.
1	Standard commercial container with electrically welded heads. Size 16 in. x 10 ft.	1925 (1820)	....	2150 (2040)	Longitudinal crack started at nipple	7770	870	1780	9800	15000
2	Standard type container with gas welded heads. Size 16 in. x 10 ft.	....	2150 (2040)	2200 (2090)	Head forced off	7960	900	1820	10500	16000
3	Standard type container with riveted heads: Size 16 in. x 10 ft.	1200 (1120)	....	2100 (2000)	Excessive Leakage	....	....	....	....	....
4	Container with gas welded heads and gas welded longitudinal butt joints. Size 16 in. x 5 ft. (Weld by Le Quelle)	.....	.....	1600 (1540)	Split along long. butt weld	.....	.....	.....	.....	.....
5	Container with gas welded heads and gas welded longitudinal butt joints. Size 16 in. x 5 ft. (Weld by Vilter)	.....	.....	1300 (1240)	Split along long. butt weld	.....	.....	.....	.....	.....
6	Container with electrically welded heads and electrically welded longitudinal butt joints. Size 16 in. x 5 ft.	.....	.....	1400 (1340)	Split along long. butt. weld	.....	.....	.....	.....	.....
7	Reinforced container with electrically welded heads (3 concentric shells, concrete filled). Size 10 in., 12 in., 14 in. x 3 ft. 2 in.	.....	4500 (4800)	4800 (4680)	Head forced off	11860	.....	.....	18000	.....
8	Reinforced container with gas welded heads (3 concentric shells, concrete filled). Size 10 in., 12 in., 14 in. x 3 ft. 2 in.	4350 (4230)	4100 (3980)	4350 (4230)	Excessive leakage at weld joints	10720	.....	.....	.....	.....
9	Special container with one head electrically welded; one head riveted. Size 16 in. x 2 ft.	1750 (1670)	.....	2500 (2390)	Split along lap weld	9100	.....	.....	11600	17600

order to compare the work of different operators, two similar gas-welded specimens were made up, the welds being made by different operators. A summary of the results obtained is presented in the table.

Conclusions

Some of the more important points brought out by the tests were enumerated and are discussed here:

Weak Points in the Containers—None of the welded containers of standard design failed primarily at the welded head joint. The nature of the fractures shows that the weak points in the containers were, first, the lap weld in the pipe forming the shell, where failure occurred due to circumferential tension, and second, the body of the shell at its junction with the head flange, where failure occurred due to the combination of longitudinal tension and bending. It appears that leakage is likely to occur first where couplings and nipples are welded in. This is due to the fact that the metal of the shell stretches and pulls away from the nipple, which does not have a corresponding strain induced in it by internal pressure.

Strength of Electric Welds—From the tests on four especially prepared specimens the average tensile strength of electrically welded joints was found to be 28,500 lb. per sq.in. From tests on five specimens cut from containers the average shearing strength of electrically welded joints was found to be 25,500 lb. per sq.in. The mean variation from the average tensile strength per linear inch of weld was found to be 2 per cent, and the maximum variation 4.5 per cent. The mean variation from the average shearing strength per linear inch of joint was found to be 5.2 per cent, and the maximum variation 7.8 per cent.

In the case of the riveted containers leakage occurred at the head joints under moderate pressures; in the case of electrically welded containers there was no leakage at the head joint under any pressure.

Metal in the Weld—Microphotographs taken of sections through gas and electric welds, both chosen at random,

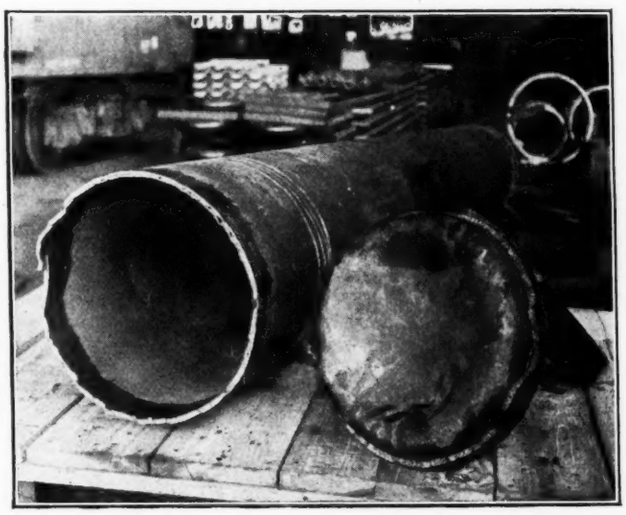


FIG. 2. SPECIMEN NO. 2 (GAS WELDED) SHOWING FRACTURE AND INNER SIDE OF REVERSED HEAD

showed almost perfect uniformity of structure and freedom from iron oxide or other impurities. In none of the specimens of electrically welded metal where fracture occurred at the weld was there any indication of porosity, imperfect coalescence or flaw of any kind. In the gas-welded specimens tested in shear, there were found spots on the surfaces of fracture where the parts had not united.

Specimens cut from along the center line of both electric and gas welds and tested in tension failed at their yield point, which was for the electric weld higher and for the gas weld lower than the yield point of the base metal as determined by test on a similar specimen cut from the plate some distance from the weld. The ultimate strength of the base metal was considerably higher and the percentage elongation much higher than for the metal from the welds. Shear tests showed that the metal from the welds was slightly inferior in shearing strength to the metal of the welding bars and considerably inferior to the base metal.

Efficiency of Joint—The writer believes that the correct method of computing the efficiency of an electrically welded

FIG. 3. SPECIMEN NO. 1 (ELECTRICALLY WELDED) AFTER TESTING, SHOWING FRACTURES

joint is on the basis of a specified minimum strength of base metal, a specified minimum excess thickness of weld, and an experimentally determined average strength (per square inch) of the finished weld. This method is the one first illustrated above.

Safety Progress in Power Generation and Distribution

The reduction that has been made during the last ten years in the dangers threatening those employed in the production and distribution of power was strikingly brought out at the meeting of the American Society of Safety Engineers, which was held on May 19, in the Engineering Societies' Building, New York City.

In a paper entitled "Safety Provisions in the Production of Light and Power," E. W. Gorry, superintendent of substations, United Electric Light and Power Co., New York City, told of the extensive accident-prevention work carried on by his company. Referring particularly to the Sherman Creek plant, he mentioned among others the following safety devices, methods and rules: (a) The wearing of helmets by men working in coal barges to prevent injury by coal falling from the unloading buckets; (b) protected gage glasses; (c) rule that no one can enter coal bunkers without life line attached; (d) grade crossings of coal-handling cableroads provided with warning bells; (e) boiler tubes inspected every twenty-four hours for leaks; (f) rule that after replacing gage glass in boiler under pressure, operator must return to floor before opening the connecting cocks; (g) automatic safety stops and self-closing valves on turbines.

Mr. Gorry also described in detail the elaborate precautions taken to prevent injury to men working on apparatus or lines. These included stringent regulations in regard to methods of grounding and the use of hold-off permits. The company maintained, he said, instruction classes in safety methods, including the use of the pulmotor and other methods of resuscitation.

Following this paper, E. M. Van Norden, civil engineer with the New York Edison Co., gave an illuminating description of the safety features of the New Hell Gate Power Station[1]. These he listed under four general headings, as follows: (1) Shop or repair end; (2) coal and ash handling; (3) equipment (mechanical and electrical); (4) structure itself.

A short abstract of the talk follows:

From records recently made in New York City, it appears that the distribution of accidents in the four divisions just named are about as follows: (1) Accidents due to the shop and repair end, 62 per cent; (2) accidents due to coal

[1]The details of this plant are described in the May 2, May 9 and May 16 issues of *Power*.

and ash handling, 32 per cent; (3 and 4) accidents due to equipment and to structure itself, 6 per cent. These percentages are based on records kept at the Waterside (New York) station for the year 1921 and covering a total of 243 accidents.

It might be expected that the greater part of the accidents in a modern power plant would be due to the high-tension electrical equipment. The percentages just given show clearly that this is far from being the case. In fact, if judged by number alone, such accidents are almost negligible, although they are ordinarily more serious than others and involve a high percentage of fatalities.

Central-Station Equipment Well Protected

The reason for the remarkably low percentage of electrical accidents in the power plant is that the hazard of high-voltage current was realized many years ago and strenuous steps taken to eliminate it so far as humanly possible. The protection of electrical equipment in central stations has been practically perfected. The important thing now is that designers and operators turn their attention to the hazards involved in the shop and repair end and in the coal and ash handling.

In these respects the new Hell Gate station marks a great advance, particularly in the field of coal and ash handling. Coal handling from barge to overhead cable roads is necessarily a dangerous operation, since there is always some chance of pieces of coal falling from the bucket. One of the most practical methods of reducing this hazard is to reduce the percentage of the coal that must be taken out of the barges with the assistance of shovelers. The greater the capacity of the barges, the smaller is this percentage. For example, a barge containing from 800 to 1,800 tons of coal can be unloaded about 75 per cent of its capacity before shovelers need to be introduced. At Hell Gate a channel has been dredged at great expense that will permit the use of 500-ft. coal barges drawing 35 ft. and carrying 10,000 tons of coal. In fact, any boat that can get up the East River can be unloaded at this plant. However, the largest barge to date carried 5,200 tons, all but 600 tons of which was unloaded without manual labor. In other words, with barges of this size, manual labor need be used for only about 12 per cent of the unloading, or half what would be required with a 1,000-ton barge. This produces a corresponding reduction in accidents.

The overhead coal-handling cable road at Hell Gate is equipped with warning signals at the grade crossings. Coal storage is cared for in the yard with the result that there is no possibility of spontaneous combustion or of stoppage in the boiler-room bunkers, so that it is never necessary for men to enter them. The coal larries carry the coal safely and conveniently from the bunker to the boiler, so that the boiler-room coal-handling hazard has been practically eliminated. In the same way ash handling, which has been the cause of many accidents at other plants, has been made absolutely safe by the hydraulic system of ash removal.

Under the heading of equipment hazards, Hell Gate has taken many precautions, including the extensive use of remote-controlled, motor-operated gate valves.

Many Unusual Safety Devices

From the safety point of view there is much that is unique in the structure. For one thing, the segregation of phases in the electrical galleries has been carried to the limit. Again, in designing the electrical galleries, it was considered unwise to use a steel structure in spite of the great strength required. The reason for this was that the closed loops of structural steel would become dangerously warm from induced currents. It was therefore decided to use reinforced concrete with a provision in the specifications that no two reinforcing bars should be in contact. This provision, which eliminates any hazards due to induced current, is believed to be unique in concrete construction.

In the operating room itself, it is important to note that there is no skylight (monitor). These have been a source of annoyance and danger at other stations, on account of the formation of condensation that falls on the electrical apparatus beneath. The design and location of the Hell Gate station was such that it was possible to use many large windows, so that the skylight became unnecessary. These windows can be operated in groups by motors.

The present operating force consists of about 200 men, of whom 50 per cent are in the day watch and 25 per cent in each of the two night watches. When the plant reaches its ultimate capacity, 300,000 kw., it will employ about 400 men. Attention has been given, not only to the safety, but to the comfort and general well being of these men. Important in this connection is the administration and welfare building which contains a lunch room, library, etc.

The meeting closed with a paper by M. G. Lloyd, chief of Safety Section, Department of Commerce, Washington, D. C., on the present status of the National Electrical Safety Code. This paper, dealing almost exclusively with regulations covering electrical distributing systems, will not be abstracted here.

Outdoor and Semi-Outdoor Hydro-Electric Power Stations*

The success of outdoor transformer substations in practically all climates, with savings in capital costs and without loss of efficiency and reliability in operation, has focused the attention of the designer on the possibility of further capital savings through the omission of the building, housing hydro-electric generating equipment. In every new project the operator should be consulted for his views as to the objections and the expediency of the omission.

The question of making the generating station of the outdoor type appears to be entirely one of cost. It seems to be the general opinion that there is not any possibility of increasing the efficiency or reliability of the plant by omitting the building, but, on the contrary, that there is a serious risk that the efficiency may be lowered and reliability impaired. Nevertheless, the discussions that have ensued have resulted in some savings, because, while there is yet no completely outdoor-type station, semi-outdoor types are now accepted and freely discussed.

An extreme case of an outdoor generating station would be one made up principally of a substructure with the necessary water passages to and from the turbines, with a working deck at about the turbine level, on which would be installed all control and auxiliary equipment that could be made weatherproof, and below this deck would be housed the relatively small amount that the designer would admit could not be weatherproofed or would not pay to weatherproof. The electric generators would be either on or above the working deck, depending on the type of unit. Necessary appurtenances to such a station would be a moving crane of some sort to facilitate erection or maintenance, and a shelter for the switchboard and operators.

Special conditions might require that no serious consideration be given to such a station. Local conditions might require a building monumental in character to conform to established development plans and amply justify the expenditure. A large amount of distributing feeders and switch gear, not easily placed elsewhere owing to space limitations, might result in a building of a number of floors and actually be the limiting factor in determining its size.

Manufacturers of hydraulic and electrical apparatus state that practically all their equipment can be made weatherproof at additional, and in most cases unknown, although probably substantial costs, so that the initiative leading to a complete outdoor station rests largely in the hands of the designer and operator. The step, however, might be attended with some difficulty, because a certain amount of development and experimental work would be necessary.

Operators at present do not favor the outdoor generating station. Practically all operators are familiar with the outdoor substation, but appear to believe that there are enough objections to the outdoor generating station to outweigh the saving in capital cost. They prefer to see moving equipment housed, believing that there will be some difficulties in making it entirely weatherpoof, and further, that it is important that the operating staff in performing

*Abstract from N. E. L. A., Hydraulic Power Committee's report.

its regular duties should be sheltered. They believe that this will result in better morale of the operating forces and more efficient operation.

In small automatic stations the objections in behalf of the operating man would not be justified, and undoubtedly the development of the automatic station will stimulate interest in the outdoor station. The statement is also made that the saving in first cost is small and hardly worth while when all factors are properly taken into account, and the caution is given that all factors entering into it be taken at their correct value.

Consideration of the advantages of outdoor stations has brought about a simplification of generating-station superstructure and a general appreciation and understanding of the so-called "semi-outdoor" type. These also appear to be limited to localities not requiring esthetic treatment or to conditions not calling for large housing capacity for electrical control gear.

Basicly, the semi-outdoor station consists of individual housing of generating units, with connecting passages for communication by operators and a separate small building for a switchboard. A moving crane, either gantry, locomotive or other type, would be provided for dismantling equipment through hatchways in the generator housings. The opinion has been expressed that the advantages of an individual housing, with narrow clearances, might be justified in case of single units, but where there are a number of units the saving is almost negligible.

News of the Power Commission

A preliminary permit for one year has been issued to the Northwestern Electric Co., of Portland, Ore., covering a power development on the Lewis River. The Lewis River Hydro-Electric Power Co., of Vancouver, Wash., has filed a conflicting application, which was denied on the ground that it was "not well adapted to a full practicable utilization of the power possibilities of the stream and because the company evidently lacks the financial and technical ability to carry out such an extensive project."

No action will be taken at this time by the Commission on applications covering the development of power on Sultan Creek, Washington. This decision was made after the chief engineer of the Commission called attention to conflicting applications for these rights. One application was made by the City of Everett and the other by the Sound Power Co.

Having convinced the Federal Power Commission of his ability to carry out his project, a preliminary permit for two years has been granted to Joseph B. Leighton, of Miles City, Mont. It covers a power project on Yellowstone River at Buffalo Rapids. The applicant proposes to install 15,000 hp. and to use the power for irrigation pumping and for public-utility purposes.

Thebo, Starr & Anderton, Inc., of San Francisco, Cal., have applied to the Federal Power Commission for a preliminary permit covering a project on the American River fifteen miles northwest of Placerville, Cal. The power is to be used for public-utility purposes. The primary power available is estimated at 25,000 hp., but it is the intention of the company to install equipment capable of generating 50,000 hp.

Power Possibilities of Tennessee River

The mineral resources and power possibilities of the Tennessee River and its tributaries in North Carolina, Tennessee, Alabama and Kentucky, are the subject of exhaustive reports of army engineers recently transmitted to Congress. Reference is made to possible power developments on the river from Chattanooga to Riverton, and at Coulter Shoals, 40 miles below Knoxville. Recommendation is made that a more detailed survey be authorized looking to development of the rivers for navigation and power purposes. The reports show that a large amount of hydro-electric power is now wasted annually in the upper section of the Tennessee River.

It is stated that at the Coulter Shoals a minimum 24-hour capacity of 14,000 hp. can be developed. Its transmission would be principally to Knoxville, where there is said to be a demand for power in excess of the supply. It is stated that for 90 per cent of the time in an average year 18,400 hp. would be available, while for 57 per cent of the time from 40,000 to 44,000 hp. may be developed. The initial cost of the project at the Coulter Shoals is estimated at $6,346,500, and $257,300 annually for operation if built by the Government. If built by private enterprise, the initial cost would be increased by $400,000.

Prices Bid on Hetch-Hetchy Hydro-Electric Equipment

The accompanying table shows the prices contained in the bids submitted for supplying the waterwheels, the generators and the 36-in. gate valves for the Hetch-Hetchy project at San Francisco, Cal.

The plans for the project call for four 25,000-hp. impulse waterwheels and four 20,000-kva. 11,000-volt generators. There were also required eight 36-in. gate valves with hydraulic operating cylinders.

It will be noted from the table that bids were presented for waterwheels and generators for operation at three different speeds, and for waterwheels operating at an unspecified speed, and that alternate proposals for the waterwheels were made with individual oil pressure sets and with central oil pressure systems.

PRICES IN BIDS FOR HETCH-HETCHY EQUIPMENT

WATERWHEELS

Proposition A (240 R.P.M.) Water wheels complete with all auxiliaries and individual oil pressure sets	Pelton	Allis-Chalmers
(a) Each of first two units	$70,150.00	$82,750.00
(b) Third unit	62,400.00	72,000.00
(c) Fourth unit	62,400.00	71,500.00
Proposition A—Alternates As above but with central oil pressure system		
(aa) Each of first two units	74,100.00	84,500.00
(bb) Third unit	59,400.00	74,500.00
(cc) Fourth unit	59,400.00	74,000.00
Proposition B (257 R.P.M.) With individual oil pressure sets		
(a)	66,100.00	81,500.00
(b)	58,300.00	70,500.00
(c)	58,300.00	70,000.00
Proposition B—Alternates With central oil pressure system		
(aa)	70,100.00	83,500.00
(bb)	55,300.00	72,500.00
(cc)	55,300.00	72,250.00
Proposition C (225 R.P.M.) With individual oil pressure sets		
(a)	74,500.00	84,500.00
(b)	66,500.00	73,500.00
(c)	66,500.00	73,250.00
Proposition C—Alternates With central oil pressure system		
(aa)	78,150.00	86,500.00
(bb)	63,500.00	75,500.00
(cc)	63,500.00	75,000.00
Proposition D— (Speed not specified) With individual oil pressure sets		
(a)	.....	72,250.00
(b)	.....	64,500.00
(c)	.....	64,500.00

36-IN. VALVES

Proposition I Applies if bidder furnishes valves only	Coffin	Bethlehem	Pelton
(a)	$4,960.00	$6,396.50	$6,425.00
(b)	4,435.00	6,110.00	6,205.00
(c)	4,435.00	6,110.00	6,205.00

GENERATORS

Proposition A	Westinghouse	General-Electric	Allis-Chalmers
1. (240 R.P.M.)			
(a) Each of first two units	$81,175.00	$68,890.00	$79,515.00
(b) Third unit	72,750.00	62,085.00	73,535.00
(c) Fourth unit	72,750.00	62,085.00	73,310.00
2. One motor generator exciter set	6,495.00	6,185.00	4,870.00
Proposition B			
1. (257 R.P.M.)			
(a) As above	78,750.00	66,865.00	77,500.00
(b) As above	70,350.00	60,185.00	71,435.00
(c) As above	70,350.00	60,185.00	71,210.00
2. As above	6,495.00	6,185.00	4,870.00
Proposition C			
1. (225 R.P.M.)			
(a) As above	83,400.00	69,565.00	80,735.00
(b) As above	74,950.00	62,735.00	74,450.00
(c) As above	74,950.00	62,735.00	74,225.00
2. As above	7,120.00	6,181.00	4,870.00

A $20,000,000 program of new power development is being planned by the Public Service Company of Northern Illinois, Chicago. This will mean the addition of about 200,000 kw. to the company's generating capacity. For the present about $5,000,000 will be spent.

News in the Field of Power

F. B. Jewett New President of A. I. E. E.

The new president of the American Institute of Electrical Engineers, as announced at the annual business meeting in New York City, May 19, is Frank Baldwin Jewett, chief engineer of the Western Electric Co., Inc. He joined the Institute in 1903 and became a fellow in

FRANK BALDWIN JEWETT

1912. New vice presidents, whose election was announced at the same time, are G. Faccioli, Pittsfield, Mass.; W. I. Slichter, New York; R. F. Schuchardt, Chicago; H. W. Eales, St. Louis (re-elected); H. T. Plumb, Salt Lake City, Utah. The new managers are: H. M. Hobart, Schenectady, N. Y.; Ernest Lunn, Chicago; G. L. Knight, Brooklyn, N. Y. George A. Hamilton, of Elizabeth, N. J., was re-elected treasurer.

The Institute is governed by a Board of Directors consisting of these newly elected officers and of fourteen holdover officers—five vice presidents and nine managers. The vice presidents are always elected for two-year terms and the managers for four-year terms.

Owen D. Young Heads New G. E. Board

Recently announced changes in the directorate of the General Electric Co. include the selection of Owen D. Young as the new chairman, to succeed C. A. Coffin, who has retired after forty years of service as one of the leaders of the company. Gerard Swope, president of the International General Electric Co., was chosen as president. He takes the place of E. W. Rice, Jr., who requested to be relieved of the duties of detailed organization and management in order to give his whole time and energies to the further upbuilding of the scientific, engineering and technical phases of the company's work. Anson W. Burchard was made vice chairman of the Board, and J. R. Lovejoy and G. F. Morrison were elected as directors.

Mr. Swope, the new president, was born in St. Louis, Mo., Dec. 1, 1872, and is a graduate of Massachusetts Institute of Technology in the class of 1895. Immediately on leaving the Institute, he joined the Western Electric Co., working his way up to the position of general sales manager in 1908; his work previous to that time was mainly in connection with power apparatus. Since Jan. 1, 1919, he has been president of the International General Electric Co.

A Senator's Viewpoint on Muscle Shoals

The Ford Muscle Shoals offer received a new impulse by the appearance of Thomas A. Edison before the Senate Committee on Agriculture and before a meeting of the non-partisan farm bloc of the Senate. After listening to Mr. Edison, Senator Harrison of Mississippi summed up his opinion of the status of the Muscle Shoals proposition as follows:

It is my opinion that favorable legislation affecting the development of the Tennessee River and Muscle Shoals is assured. The Congress, both in the House and in the Senate, is divided with respect to the policy of accepting Henry Ford's offer. There is no question that strong influences have been and are now at work to distort the fairness of that offer.

The Ford proposal to complete the dams, as well as plants, in the interest of navigation and for the manufacture of fertilizers at Muscle Shoals, has much merit. If the Government should accept it, the benefit to that section contiguous to the development would be immeasureably great and to the farmers of the country immeasureably greater.

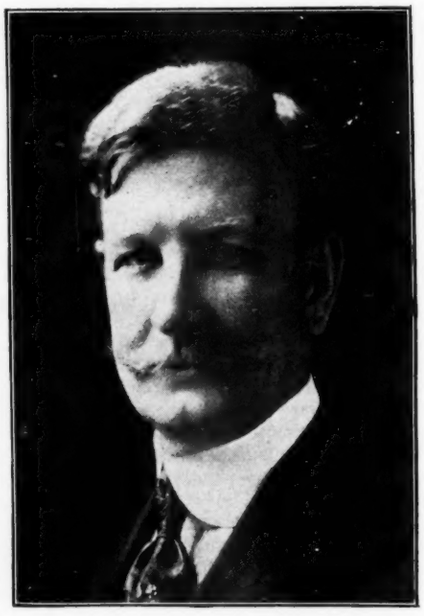
If the Ford offer should not be accepted by the Congress (and it would seem at this time that the chances are against it), it will be due to the hundred-year lease provision that is requested and the influences at work against the man, personally, making the proposal.

In the Senator's opinion, the 100-year lease would be justified in this case by the tremendous size and importance of the project. In any event, he is certain that the development will be successfully carried out in some way, saying:

I am confident, however, in the circumstances, that whether or not the Ford offer or some other proposal is accepted, the development at Muscle Shoals is assured and this Congress will either accept some proposal that will insure the success of the project or will see that it is done through direct appropriations from the Federal Government under Federal supervision.

John L. Harrington Chosen To Head A. S. M. E.

As announced in *Power's* report of the spring meeting of the American Society of Mechanical Engineers at Atlanta, Ga., published last week, the new president of the Society is to be John Lyle Harrington, who was the unanimous choice of the nominating



JOHN LYLE HARRINGTON

committee. He will take office at the annual meeting next December.

Mr. Harrington was born at Lawrence, Kan., in December, 1868. He was graduated from the University of Kansas in 1895, with several degrees, later receiving the degree of M. S. from McGill University at Montreal. After his graduation he devoted himself mainly to civil engineering, specializing on bridge and structural work. In 1901 he became executive engineer and manager of the C. W. Hunt Co., New York City, leaving in 1905 to become chief engineer and manager of the Locomotive and Machine Company of Montreal, a subsidiary of the American Locomotive Company.

From 1907 to 1914 he was engaged in consulting practice as a member of the firm of Waddell & Harrington, of Kansas City, continuing from 1914 to the present as a senior partner in the firm of Harrington, Howard & Ash, also of Kansas City. He has specialized in the design and construction of large bridges and of large movable structures of all kinds.

Mr. Harrington joined the Society in 1902 and served as its vice president, 1920-1922. He is now chairman of the Committee on Constitution and By-Laws. He is a member of a number of honorary and local societies, and also

of the American Society of Civil Engineers, the Engineering Institute of Canada, the Institution of Civil Engineers (London), the American Railway Engineering Association, and the American Society for Testing Materials.

Los Angeles to Distribute Southern California Co.'s Power

The part of the distributing properties of the Southern California Edison Co. that lies within the city limits of Los Angeles has been purchased by the city for the sum of $12,044,369.97. The city has contracted to buy at wholesale all the electric power that it needs over that generated from its own aqueduct and "will not support or lend its encouragement to any movement or measure which seeks to supplant the company by some other agency, as the source from which it is purchasing its requirements for wholesale power over and above its own production;" and the city has agreed not to compete with the company's electrical business outside of the city limits. The contract is for thirty years, but may be canceled after ten years by a vote of the people. The Edison Company is given the first right to buy any surplus power generated by the municipal plants, not required in the city's system.

Petroleum Specifications Committee to Meet July 3

The Interdepartmental Petroleum Specifications Committee, which prepares tentative specifications for all petroleum products, including gasoline, kerosene, fuel and lubricating oils, for the United States Government, will hold an open meeting on July 3 at 9 a.m. in the auditorium of the Interior Building in Washington, D. C. At this meeting the "Specifications for Petroleum Products," which have been published as Technical Paper 305 of the Bureau of Mines, and the "Testing Methods for Petroleum Products," which have just appeared as Technical Paper 298, will be discussed in detail. It is hoped by the committee that all persons interested will feel free to be present and express their views on the subject.

Chicago Section A. S. M. E. Selects Officers

On Tuesday evening, May 16, the Chicago Section of the American Society of Mechanical Engineers held its annual meeting, which was the last of eight on the season's schedule. At a short business meeting officers were elected as follows: Horace Carpenter, chairman; R. A. Widdicombe, vice chairman; J. D. Cunningham, secretary; Edward P. Rich and G. E. Pfisterer. The secretary was able to report the largest balance the Chicago section had ever had and reviewed briefly the season's work consisting of eight meetings, five of which had been joint gatherings with the Western Society of Engineers.

The feature of the evening was an interesting address by Major Schroeder on some of his work as chief testing pilot while in the employ of the Government air service. Until recently the major held the world's altitude record of 38,780 ft. His account of his experiences, the results obtained, the dangers encountered, accompanied by motion pictures of the work showing the equipment used, the clothing of the pilot, landing difficulties, parachute tests, etc., was of absorbing interest to the audience. At the conclusion of his address the courtesy of the H W. Johns-Manville Co. made available a series of reels showing the mining of asbestos, its preparation and the making of the various products handled by the company.

Help the Government with Coal-Storage Data

The United States Bureau of Mines is making a thorough study of the subject of coal storage in order to obtain information the results of which ought to prove of great value to coal consumers. The Bureau is particularly anxious to hear from all those who have had experience in the storage of coal, and has asked that the readers of *Power* be told of its work, and urged to give it the benefit of their views and conclusions on the following items:

Method of storage — under water or not, closed sheds or in the open, kind of floor or ground; location of storage with reference to point where coal is to be used; maximum and average quantity stored; methods of preventing spontaneous combustion; method of handling fires; devices used for observing temperature and inspection; danger point as regards temperature; deterioration in sizes and also in heating value in stored coal; in your practice what tonnage can be stored per acre of available space? depth of pile—maximum allowed; kinds of coal stored—district from or trade name; size stored; is coal screened before storing? how long coal must be stored? best time of year to store; cost of storage plant and cost of maintenance; cost of handling in and out of storage—transportation to pile; transportation from pile to point of use; effect of climate on stored coal, if any; costs of unloading and releasing; method of handling in and out of storage; cost of investment and fixed charges.

The Bureau reports that although there has been agitation as to the possibilities of storing coal, so as to eliminate the evils of seasonal production at the mine, very little exact information is available, especially as to costs of handling and transportation in and out of storage, as well as of the investment, fixed charges, etc., involved. There is hardly a single consumer of coal who does not need such information, and if each one will tell the Bureau what he knows about the subjects, the results ought surely to be of great benefit to all. It would therefore be not only a brotherly act, but a piece of good business to take the foregoing list of items as a questionnaire and send the information requested to the Bureau of Mines. It should be addressed to F. R. Wadleigh, Commercial Engineer, Bureau of Mines, Washington, D. C. Information that is furnished will be acknowledged and will be treated as confidential if desired.

Boiler Manufacturers Going to Shawnee June 5

The American Boiler Manufacturers' Association has announced the program for its thirty-fourth annual convention, which is to be held June 5, 6 and 7 at Buckwood Inn, Shawnee-on-Delaware, Pa., where opportunities for outdoor sports (especially golf) and social diversions will add to the attraction of the business meetings and the technical papers.

The convention will start off Monday morning with reports from E. R. Fish, representing the A. S. M. E. Boiler Code Committee; Charles E. Gorton, chairman of the American Uniform Boiler Law Society; Joseph F. Scott, chairman of the National Board of Boiler and Pressure Vessel Inspectors, and C. O. Myers, secretary-treasurer of the latter. In the evening E. C. Fisher, of the Wickes Boiler Co., will give a paper on "A Study of Thickness of Shell Plates in Return Tubular Boilers," and R. Sanford Riley will give a talk with his much discussed motion picture of stoker operation.

On Tuesday there will be an address by M. W. Alexander, managing director of the National Industrial Conference Board, followed by reports of the various standing committees.

On Wednesday there will be an address by Dr. Charles Aubrey Eaton, of the American Educational Association, followed by the election of officers and a preliminary report from L. E. Connelly on the A. S. M. E. Boiler Code Sub-Committee on "Rules for Inspection of Materials and Boilers."

Second Hoover Coal Conference Set for May 31

To make effective a plan intended to prevent a runaway market in coal, a general coal price conference has been called by the Secretary of Commerce to be held in Washington, May 31. This announcement by Secretary Hoover followed the preliminary conference on May 18, at which fifty operators, representative of all the non-union fields, voted to use the Garfield schedule of prices, of Oct. 29, 1917, as a basis for fixing fair prices of coal. At the same time announcement was made that buying for the larger consumers will be done through committees so as to unify these purchases and prevent the entrance of speculators. In announcing the general price conference for May 31, Secretary Hoover said:

The administration expects coal operators in the interim before this conference not to sell coal at prices in excess of the Garfield prices, with such adjustments as are necessary to meet such changed conditions as to costs and other factors as will be fair to the public and to the operators.

Furthermore, the charging by whole-

salers or retailers of larger commissions than were allowed under the Garfield scale, or the resale of coal for speculative purposes, is not fair to the public, and the Government would like to hear from consumers who have been subjected to higher prices than this basis warrants.

The vast majority of coal operators and wholesalers everywhere are expressing approval of the action of the Administration to curb speculative rises in the price of coal and are co-operating finely with the Government to maintain this situation.

The action of the producing operators and of the wholesalers in this particular deserves the gratitude of the public, more especially as a large part of the coal produced for many months prior to the strike was produced without profit and even at a loss. The great majority of operating mines wish to demonstrate their sense of responsibility to public interests in this matter.

The object of the meeting on May 31 is to devise a means whereby this spirit of co-operation with the Government and the public can be organized and made effective.

A steering committee that was appointed at the May 18th conference suggested the following plan for the general price conference:

1. That representatives of that conference be appointed, who together with representatives of the Government departments and the operators, should be a standing committee to advise upon the co-ordination of coal distribution between districts.
2. That each district be asked to form a committee that should co-ordinate distribution and to co-operate with the standing committee.
3. The various committees should take measures to assure the direct progress of coal direct to the consumer in proportion to his needs.
4. The Garfield prices should be the basis for computing sales prices with such adjustments as are necessary to meet such changed conditions as to costs and other factors, as will be fair to the public and the operators.

Heating Engineers To Meet in Buffalo and Detroit

The approaching semi-annual meeting of the American Society of Heating and Ventilating Engineers will be a two-city meeting—in Buffalo, N. Y., on June 6-7, and in Detroit, Mich., June 8-10. The trip between the two cities will be made over night by boat. Headquarters will be in the Hotel Iroquois in Buffalo, and in the Wolverine in Detroit.

The first session, to be held Tuesday morning, will of course be given over to business affairs, including the reports of several committees, one of which is the committee on a code for testing fans. In the afternoon there will be a professional session, at which several papers will be given, one to be "Corrosion in Water Carrying Vessels," by J. E. McDermot. Wednesday morning the research session will begin with the report of the Committee on Research, followed by papers on results of investigations at the Research Laboratory.

Thursday morning, at Detroit, the school-ventilation session will be held, and Friday morning the pipe-size session. The papers to be given at the latter are: "Critical Velocity in One-Pipe Steam System," by F. E. Gieseke; "Dry Returns," by R. V. Frost; and "Temperature Control by Fractional Distribution of Steam," by J. A. Donnelly. The meeting will be concluded with a professional session on Saturday morning, at which three papers are to be given.

Sesquicentennial Approved

Full approval of Federal participation in the Philadelphia Sesquicentennial Exhibition has been voted by the Congressional committee on industrial arts and expositions, which has reported with certain amendments the Darrow bill and recommended that it receive the prompt approval of the House.

The bill as amended specifies that Fairmount Park shall be the site of the exposition and that the form of Federal participation is to be determined by the President.

The committee is of the opinion that the sesquicentennial will be even more potent in its influence on industry than was the exposition in 1876. In its official report to the House it predicted that the exposition in 1926 will be the greatest international affair of the kind ever held. The committee is of the opinion that it will increase the prestige of the United States abroad and will tend to make more certain the pre-eminence of America in matters commercial, financial and political.

Standards Committee and Commerce Department Co-operate

As a concrete effort to cut down waste in industry, the American Engineering Standards Committee, upon the suggestion of Mr. Hoover, is to undertake a canvass of the engineering and technical bodies that are co-operating in its work, to find out what simplification in manufactured products in their field is most needed and most desirable. The replies will be tabulated, co-ordinated and reported to the Department of Commerce. This action is in line with the findings of the Elimination of Waste Committee of the Federated American Engineering Societies, of which Mr. Hoover was the first president. This committee found that waste in industry was due largely to an over-multiplicity in number of products, as well as to inefficiency in process.

There seems to be general recognition of the fact, according to the committee, that simplification of products and improvement of process are to a large degree only other words for standardization; that they are standardization put to work. For this reason it is pointed out that the arrangement by which the Department of Commerce has delegated to the American Engineering Standards Committee the task of obtaining needed information indicates that these two bodies are applying in their own work the same principles of simplified procedure that they preach to others.

New Publications

Boiler Steel. Published by the Vulcan Boiler and General Insurance Co., Ltd., 67 King St., Manchester, England. Paper, 5½ x 8¼ in., 102 pages. Price 2s. 6d.

"Experience with high-pressure boilers is dearly bought, and it is well that what is available should be circulated," says C. Bullock, managing engineer of the company, in the preface of this book. Acting on this praiseworthy idea, he has gathered together in these pages a large number of practical bits of information on the manufacture and the operation of high-pressure steam boilers, mainly from the viewpoint of safety.

Electric Ship Propulsion. By Commander S. M. Robinson, U. S. N. Published by Simmons-Boardman Publishing Co., New York, 1922. Cloth; 6 x 8½ in.; 274 pages; 140 illustrations. Price, $6.00.

Although this book is primarily intended to deal with the electrical side of the subject, considerable space is given to the steam turbine and Diesel engine. After discussing the general subject, the author devotes 170 pages to a description of the propelling equipment on a number of American naval vessels. The steam-electrical propelling equipment of the "Wulsty Castle," which is equipped with Lungstrum turbines, is also described. The subject is presented in a readable manner, and those interested in electric ship propulsion will find much that will be of interest to them in this book.

Handbook of the National District Heating Association. Edited by the Educational Committee; published by the National District Heating Association, D. L. Gaskill, secretary-treasurer, Greenville, Ohio. Leather, 5 x 7 in., loose-leaf. Price, $5 postpaid.

While the "handbook" naturally deals with the use of steam for heating rather than power, nevertheless practically all the subjects covered apply to the problems of the power plant, and the convenient form in which the information is presented should make the book of value to power-plant men. It is prepared on the "Lefax" principle, and it is understood that the Association is to send out from time to time additional pages free of charge. Convenient index tabs divide the book into the following parts: General, generation, distribution, utilization, meters, hot-water heating, miscellaneous memoranda. The material given consists mainly of information made available in the proceedings of the association, together with some original matter and some useful descriptions of manufactured apparatus. The material is technical rather than managerial. The book is not intended to be a complete textbook, but it does represent a successful effort to put a lot of valuable and up-to-date information in most convenient form.

Society Affairs

Coming Conventions

American Boiler Manufacturers' Association; H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Annual convention at Buckwood Inn, Shawnee-on-Delaware, Pa., June 5-7.

American Order of Steam Engineers; Andrew Lauterbach, 4726 North Warnock St., Philadelphia, Pa. Annual convention and exhibition at Philadelphia, June 5-9.

Stoker Manufacturers' Association; J. G. Worker, Eau Claire, Wis. Semiannual meeting at Groton Pt., Conn., June 19-21.

National District Heating Association; D. L. Gaskill, Greenville, Ohio. Annual convention at Cedar Point, Ohio, June 20-23.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Annual convention at Niagara Falls, Ont., June 26-30.

American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, N. J., June 26-July 1.

Canadian Association of Stationary Engineers; G. C. Keith, 51 Wellington St. West, Toronto, Ont. Annual convention and exhibition at Kitchener, Ontario, June 27-29.

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual conventions and exhibitions of the State Associations scheduled as follows:

New Jersey, at Elizabeth, June 2-4; E. J. Flynn, 423 Newpoint Road, Elizabeth, N. J.

Illinois, at Chicago, June 7-10; I. S. Pieters, 1130 Clay St., Chicago.

New York, at New York City, June 8-10; T. J. Condon, 102 Seventh Ave., New York City.

Indiana, at Anderson, June 9-10; Frederick L. Ray, Anderson, Ind.

New England, at Springfield, Mass., July 12-14; James Morgan, 53 Devonshire St., Boston.

Michigan, at Kalamazoo, July 19-21; A. M. Adams, 1307 Stockbridge Ave., Kalamazoo, Mich.

Philadelphia Section, Association of Iron and Steel Electrical Engineers, is to enjoy an outing with a lot of original features on June 3. The affair will be held at Nedrona Park Iron Bridge, on the Perkiomen, Rahns Station, about a mile above Collegeville; it will last throughout the afternoon and will include a land circus, an aquatic festival, a wireless concert, etc.

Cooper Union has announced the 63rd annual reception of the Night School of Science, with inspection of the Technical Laboratories, for June 2, at 8 to 10 p. m., in the Hewitt Memorial Building.

Business Items

The Industrial Service Co., Interstate Building, Kansas City, Mo., has been formed by C. O. Sandstrom, W. W. Wheeler and R. C. Clark to engage in the general practice of engineering and construction. Attention will be given to design, construction, operation, valuation, etc., of power, refrigeration and similar plants.

The New York State Gas and Electric Corporation, of Ithaca, N. Y. and other cities, has acquired the properties of the Ovid Electric Co., the Tompkins County Power Corporation and the Standard Light, Heat and Power Co., is considering a transmission line from Oneonta to Norwich, and has recently placed orders for a new 3,000-kw. turbine and 5,000-sq.ft. boiler.

Johns-Manville, Inc., (formerly H. W. Johns-Manville Co.) and the Johns-Pratt Co., of Hartford, Conn., for which it has acted as exclusive selling agent for many years, have decided to manufacture and market their respective products separately. The connection was first established in 1887, and it is now felt that the changed business conditions in the electrical trade make it more economical to all concerned for each manufacturer to sell direct through organized distributors.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	May 15, 1922	May 22, 1922
Pool 1,	New York	....	.....
Smokeless,	Columbus	$2.90	.....
Clearfield,	Boston	3.25	$3.00@3.60
Somerset,	Boston	3.50	3.50@4.00
Kanawha,	Columbus	3.00	3.75@4.50
Hocking,	Columbus	2.90	3.00@3.50
Pittsburgh No. 8	Cleveland	3.25	3.50@3.75
Franklin, Ill.,	Chicago	4.15	3.75@4.00
Central, Ill.,	Chicago	....	.....
Ind. 4th Vein,	Chicago	....	.....
West Ky.,	Louisville	3.15	3.00@3.50
Big Seam,	Birmingham	1.70	1.50@1.90
S. E. Ky.,	Louisville	3.00	3.25@3.50

New York—May 25, Port Arthur light oil 22@25 deg. Baumé 3¼c. per gal.; 30@35 deg., 4⅜c. per gal., f.o.b. Bayonne, N. J.

Chicago—May 20, for 24@28 deg. Baumé, 85@90c. per bbl.; 21@36 deg., 2⅜@2½c. per gal. in tank cars, f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—Apr. 25, f.o.b. refinery, Pennsylvania, 36@40 deg. 4⅜c. Kentucky fuel oil, 26@30 deg., 3c. per gal. Western, 24@30 deg., 85c. per bbl.; 32@34 deg., 3c. 36@38 deg. 3¼c. 38@40 deg., 3½c. per gal.

St. Louis—Mar. 25, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 90c. per bbl.; 26@28 deg., 95c.; 28@30 deg., $1.10; 32@34 deg. 2¾c. per gal.

Philadelphia—May 22, 26@28 deg. Baumé, Oklahoma, 75@80c. per bbl.; 30@34 deg., Oklahoma (group 3), 2⅜@2¾c. per gal.; 16@20 deg. Seaboard, $1.10@$1.25 per bbl.

Cincinnati—May 17, for 26@30 deg. Baumé, 5c.; Diesel 32@34 deg., 5½c. per gal.; distillate 38@48 deg., 5¾c.

Cleveland — May 17, 26@30 deg. Baumé, 4c. per gal.

New Plant Construction

PROPOSED WORK

Ala., Tuskegee—J. A. Wetmore, Acting Superv. Archt., Treas. Dept., Wash., D. C., will receive bids until June 22 for boiler plant (except building and smokestack) the outside heating, electric water and sewer services, deep wells, pumping plant and water supply systems and sewage disposal plant for the U. S. Veterans' Hospital, here.

Ariz., Prescott—Bids will be received by Supt. of Constr., U. S. Veterans' Hospital, Whipple Barracks, until June 15 for electric light, power and telephone systems at U. S Hospital, here. J. A. Wetmore, Treasury Dept., Wash., D. C., Acting Superv. Archt.

Cal., San Francisco—William Houghteling, et al., c/o Weeks & Day, Archts., Phelan Bldg., is having preliminary plans prepared for a 1 story market building on 8th and Market Sts. About $500,000.

Cal., Stockton—The city voted $600,000 bonds to build an auditorium on a block bounded by Commerce, Oak, Fremont and Center Sts. L. S. Stone, Belding Bldg., W. J. Wright, Bank of Italy Bldg., and G. Allen, 37 South Aurora St., Archts.

Fla., Miami—N. L. Stevenson and associates, Miami, are having plans prepared by Hampton & Reinert, Archts., Miami, for a 6 story, 70 x 80 ft. apartment at Fort Dallas Park. About $500.000.

Ill., Chicago—R. T. Davis, c/o R. F. France, Archt., 155 North Clark St., is having plans prepared for 12 story, 100 x 109 ft., apartment house on Delaware Pl. and Seneca St. About $1,000,000.

Ind., Marion—The Spencer Hotel Co. is having revised plans prepared for a 6 story, 50 x 60 ft. hotel. Estimated cost $450,000. Vonnegut, Bohn & Mueller, Indiana Trust Bldg., Indianapolis, Archts.

Ind., Whiting—Shattuck & Layer, Archts., 19 South La Salle St., Chicago, are receiving bids for a 2 story, 140 x 260 ft. community house, including steam heating system on Short and Clark Sts., for The Standard Oil Co. Estimated cost $500,000.

Mass., Boston—Trader's Realty Trust, c/o Burtis Brown, Engr., 88 Broad St., is having plans prepared for an 11 story mercantile building at Kneeland St. and Harrison Ave. About $500,000.

Mass., West Springfield—The town, H. K. Chandler, Chn. Com., 76 Bliss St., is having plans prepared by C. G. Loring, Archt., 7 Water St., Boston, for a 3 story Junior High School on Elm St. About $350,000. Noted Jan. 3.

Mich., Kalamazoo — The Kalamazoo Vegetable Parchment Co., River Rd., plans addition to paper mill, including steam heating and power equipment. Estimate cost $500,000. Billingham & Cobb. Press Blk., Archts.

Mich., Springwells—B. P. Esper, Clk., received bids for furnishing and installing pumping equipment for sewage treatment works from Midwest Eng. Co., 617 Fulton St., Chicago; Water Works Equipment Co., 50 Church St., New York, $36,300; J. L. Skelton, 272 Water St., Toledo, O., $36,300. Noted Apr. 11.

Minn., Sauk Center—The city, Victor Conklin, Secy., Water, Light & Power Comn., will receive bids until June 9 for improving water system, including distribution system, rein.-con. or steel water tower, pumping equipment, etc. L. P. Wolff, 1101 Guardian Life Bldg., St. Paul, engr.

Neb., Lawrence—The Village, F. Rischling, Clk., will take bids about June 15 for a transmission and distribution system. Estimated cost $12,000. Hollister Eng. Co., 517 Bankers Life Bldg., Lincoln, Engrs.

N. Y., Batavia—The Bd. Educ. will receive bids until June 12 for a 3 story, 144 x 200 ft. school on Ross St. About $450,000. Bids will be received at the same time for heating and ventilating systems.

N. Y., Buffalo — The Buffalo General Electric Co., Inc., Electric Bldg., is in the market for machinery and equipment for proposed substation on Gladstone and Short Sts.

N. Y., Jamestown—The city received bids for furnishing and installing ash handling equipment at the new Steele St. lighting plant, from Connery Co., Broad St., Phila., $7,163; Jeffery Mfg., Co., Columbus, O., $8,350; Specialty Eng. Co., Phila., $9,580.

N. Y., Johnson City—The Binghamton Light, Heat & Power Co., 172 Washington St., Binghamton, has had plans prepared by Hoadley & Giles, Engrs., Phelps Bldg., Binghamton, for 38 mi. of high tension transmission line extending from Johnson City to Sayre, Pa. Line will be built on wood poles, double circuit, 33,000 volt. Insulators will be spaced for later use at 66,000 volts. Cost to exceed $200,000. Noted May 9 under "Binghamton."

N. Y., New York—The New York Times, Times Square, will soon receive bids for an 11 story, 100 x 143 ft. printing plant and office building at 217 West 43rd St. Ludlow & Peabody, 101 Park Ave., archts. and Engrs. Noted Jan. 10.

N. Y., New York—The Selmer Mercantile Corp., 15 Moore St., is in the market for four double cylinder, single drum friction coal hoisting steam engines.

N. Y., New York—The VanRenssalaer Estates, Inc., c/o Schwartz & Gross, Archts., 341 5th Ave., will build a 14 story apartment hotel on Bway. and 91st St. Work will be done by separate contracts under supervision of the architects.

N. Y., Olean — Niagara, Lockport & Ontario Power Co., Hinman Rd., Lockport plans to purchase the Olean & Bradford plants and stock of the Bradford Electric Co., and to build a high tension wire from Gardenville to Olean including steel tower line with two circuits.

N. Y., Richmond Hill—The Bd. Educ., 500 Park Ave., New York, plans to construct a brick, steel and stone school between 12th and 13th Aves., near Grand Ave., to be known as P. S. No. 70. About $850,000. C. B. J. Snyder, Municipal Bldg., New York, Archt and Engr.

N. C., Raleigh—The Meredith Baptist College plans to construct college at the outskirts of the city. About $1,000,000. C. E. Brewer, Raleigh, Pres.

N. D., Hillsboro—N. G. Nvhus, Aud, will receive bids until June 5 for an electric distribution and lighting system. Present plant to be discontinued and A. C. distribution system to be built, to be served by transmission line. About $35,000. C. L. Pillsbury Co., 1200 2nd Ave., S., Minneapolis, Engr.

Ohio, Akron—The Northern Ohio Traction & Light Co., North Main St. plans to make additions to power and light plant including distribution lines, etc. Estimated cost $175,000.

O., Conneaut—The Bd. Educ., is having revised plans prepared for a 1 story, 250 x 300 ft. junior high school on block bounded by Mill, Sandusky, Adams and Jackson Sts. About $300,000. Bartholomew, McCullough & Smith, Ferguson Bldg., Pittsburg, Pa., Archts. Noted March 21.

O., Springfield—The Bd. Educ. will receive bids until June 9 for a 2 story high school. Tbout $300,000.

Okla., Bristow—The City Clk., will receive bids until June 5 for waterworks extensions 250,000 gal. reservoir, pump house and deep wells including 1-300 GPM 200 head motor driven centrifugal pumping unit, 1-750 GPM 200 head marine engine driven centrifugal pumping unit, 3-120 GPM deep well pumping units. Estimated cost $52,000. V. V. Long & Co., Colcord Bldg., Oklahoma City, Engrs.

Okla., Miami—The North East Oklahoma Railway Co. plans to construct an electric railway from Miami to Pawhuska. Project will include a power plant at Pawhuska. About $550,000. H. B. Cobban, Miami, Ch. Engr.

Pa., Altoona—The Bd. of Dir. of the School Dist., 6th Ave. and 15th St., will receive bids until June 12 for the completion of the vacuum heating system in the High School also installing new ventilating and vacuum steam heating system and force air warming systems in Lincoln and Emerson Schools, connecting to central heating and power plant. Shevlin Eng. Co., Inc., 110 West 34th St., New York, Engrs. Noted Feb. 28.

Pa., Farrell — Borough, J. W. Kozar, Sec'y., will receive bids until June 6 for furnishing pumping equipment for 5⅛ in. diameter deep well.

Pa., Johnstown — The Schubert Theater Co., c/o J. L. Simler will soon receive bids for a 2 story, 135 x 85 ft. theater on Franklin and Vine Sts. Estimated cost $500,000. H. J. Krapp, 114 East 16th St., New York City, Archt. and Engr.

Pa., Phila. — The Allen Eng. Co., 24 North 55th St., is in the market for a number of double drum hoisting engines with boilers.

Pa., Rochester—Dawes, Ahrens, McKiney Co., is having plans prepared for a factory and power plant. Estimated cost $90,000. The Austin Co., 16112 Euclid Ave., Cleveland Ohio, Engrs.

Tex., Dallas — The Stickle Lumber Co., Maple Ave., Rd., plans to improve its plant, including the installation of five high pressure boilers, total capacity 750 hp.; lighting plant and water and sewerage systems. All machinery units to be electrically driven. About $300,000. A. W. Stickle, Pres.

Tex., Jacksonville — The city plans to install electrically driven pumps and motors in connection with improvements to the waterworks. H. N. Roberts, Box 9, Longview, Engr.

Wis., Gillett—The Bd. Educ., c/o H. Kaster, plans to install a new steam heating system in the high school. Project will include a 200 hp. boiler. About $60,000.

Wis., Oshkosh—The Mercy Hospital, 185 Hazel St., will receive bids about June 8 for a 3 story, 40 x 100 ft. convent and a 2 story, 40 x 70 ft. boiler house and laundry. About $150,000. E. Brielmaier & Sons, 432 Bway., Milwaukee, Archts. Noted Apr. 25.

Wis., Spring Green — The village, A. Schlosser, Clk., is receiving bids for equipment in connection with improvements to the waterworks, including pump, motor, and engine. W. G. Kirchoff, Vroman Blk., Madison, Engr.

Ont., London—The Utilities Bd. plans to extend the water system. Prices are wanted immediately on one deep well pump, daily capacity, 1,000,000 imperial gallons. E. V. Buchanan, Utilities Bldg., Engr.

Ont., London—City Council, J. C. Wilson, Mayor, having plans prepared and soon receives bids for a city hall, including a steam heating system on Dundas St. Estimated cost $300,000. A. M. Piper, City Hall, Archt.

Ont., Oakville—The City Council plans to install an auxiliary gasoline engine and pump. About $32,000. Chipman & Power, Mail Bldg., Toronto, Engrs.

Ont., Owen Sound—The Bd. Educ. plans to construct a technical school, including a steam heating system. Prices are wanted on boilers, etc. About $200,000. F. H. Rutherford, Secy.

Ont., Petrolia—The town will soon receive bids for a pumphouse and electric pumps in connection with improvements to the waterworks. J. McHattie, Clk. James, Proctor & Redfern, 36 Toronto St., Toronto, Engrs.

Ont., Toronto—The City, C. A. Maguire, Mayor, Room 12, City Hall, will receive bids until June 13 for 1-4,000,000 imperial gal. centrifugal pump.

Ont., Welland—The St. Thomas Packing Co. St. Thomas, plans to construct a cold storage plant here and is in the market for equipment. W. Moody, Mgr.

Ont., Wiarton—The Town Council plans to either completely rebuild the existing pump at the waterworks or install a new one, rebuild present motor, install Venturi meter and replace defective water mains. Bylaw will be voted on to defray cost. About $20,000. F. W. Thorold, Town Hall, Engr.

CONTRACTS AWARDED

Cal., Long Beach—E. John, c/o W. H. Austin, Archt., First Natl. Bank Bldg., has awarded the contract for a 12 story, 100 x 100 ft. bank and office building on Broadway and American Ave., including steam heating system, to J. D. Sherer, 1865 East Anaheim St. $681,000.

Cal., Oakland — East Bay Water Co., 512 16th St., will build a pumping station on East 39th St. Estimated cost $5,000. Work to be done by day labor.

Cal., Oakland — Oakland Bank of Savings, has awarded contract for a 16 story office and bank building on 12th St. and Broadway to P. J. Walker Co., Monadnock Bldg., San Francisco. About $1,000,000.

Cal., Richmond—The Richmond School Dist. has awarded the contract for installing a heating system in the proposed new high school on 9th and Bissel Aves., to the Scott Co., 381 11th St., Oakland, $31,988.

Cal., San Jose — Security Warehouse & Cold Storage Co., 350 North First St. has awarded the contract for a refrigerating plant to F. Hoyt, 343 Reed St. About $23,000.

Ill., Chicago — Rebori, Wentworth & Dewey, 410 South Mich. Blvd., Archts., have awarded contract for a 2 story, 90 x 149 ft. apartment on Schiller and Dearborn Sts., to Dahl-Stedman Constr. Co., 11 South La Salle St. Estimated cost $300,000. A steam heating system will be installed. Owners name withheld.

Ill., Decatur—The city has awarded the contract for a sewage filtration plant to L. N. Cope & Son, Decatur, $567,630.

Ind., Ft. Wayne — Lincoln Natl. Life Insurance Co., Lincoln Life Bldg., has awarded contract for a 3 story, 264 x 114 ft. office building on Harrison St. to Hegeman & Harris, 185 Madison Ave., New York, City. Estimated cost $1,000,000. Noted May 16.

Ind., Indianapolis—C. E. Pauley & Co., 112 East Maryland St., has awarded the contract for a 5 story 95 x 135 ft. printing plant on North New Jersey St. to Thompson & Binger Co., Pythian Bldg. Estimated cost $225,000.

Mass., Boston—The Bostonian, Inc., 75 State St., has awarded the contract for a 10-story hotel on Arlington and St. James Sts., to the Boyle-Robertson Constr. Co., 601 Evans Bldg., Washington, D. C. About $5,000,000. Noted Dec. 27.

Minn., Crosby—The village has awarded the contract for a deep well pump, capacity 500 gal. per min., with electric motor, 3 phase, 60 cycle, 220 volt, to the Kent Eng. Co., Omaha, Neb., $3,232. Noted May 9.

N. Y., Medina—The Bd. Educ. has awarded the contract for a 3 story, 180 x 200 ft. high school to Snyder & Gillette, Niagara Falls, $264,800; electric work to the Buffalo Electric Co., Buffalo, $8,816. Noted April 4.

N. C., Greensboro—The Jefferson Standard Life Ins. Co., has awarded contract for a 17 story 115 x 187 ft. office building, including heating system etc. on Market St. to G. A. Fuller Constr. Co., Munsey Bldg., Wash., D. C. About $2,000,000. Noted April 25.

Ohio, Cleveland — The Kirk-Latty Co., 1971 West 85th St., has awarded contract for a 41 x 44 ft. boiler house to J. J. Cassidy, 9718 Baltic Rd. Estimated cost $40,000.

Ohio, Cleveland—The S. S. Kresge Co., Kresge Bldg., Detroit, Mich. has awarded contract for a 4 story, 50 x 200 ft. store and office, including a steam heating system, on East 4th St. and Euclid Ave. to Craig-Curtiss Co., Cook Bldg. Estimated cost $300,000.

Ohio, Cleveland—Ohio Provision Co., E. L. Schneider, West 61st St., and Clark Ave., has awarded contract for a 58 x 60 ft. boiler house on Clark Ave. and Big Four R.R. to W. I. Thompson & Son Co., 5103 Euclid Ave. Estimated cost $40,000.

Pa., Greensburg — The Westmoorland Hospital has awarded contract for addition to hospital to Burrell & Snyder. Estimated cost $500,000. Noted May 9.

Pa., Phila.—The Jefferson Medical College of Phila., Sanson St., has awarded contract for a 14 story addition to hospital on Sanson St., Stone & Webster, 120 Bway., New York City. Estimated cost $1,500,000.

Tenn., Nashville—The National Life & Accident Bldg., 7th Ave., has awarded the contract for a 5 story office building at 7th Ave. and Union St., to the Foster-Creighton Co., 4th and 1st Natl. Bank Bldg. About $500,000.

Wis., Delavan—The City Water Comn., K. Hallister, Clk., has awarded contract for water mains, 30 ft. open well, and pump house to Swords Brothers, Rockford, Ill., $16,782. Equipment not included. Noted April 11

Ont. Crediton—The Council, H. Eilber, clk. has awarded contract for a lighting and power distribution system, including about 3 miles of transmission line to the Ontarion Hydro Power Comn., 190 University Ave., Toronto. Estimated cost $35,000. Noted April 11.

Ont., Kingsville — City Council has awarded contract for rebuilding pumping plant and intake and laying additional mains to J. Sherman, Main St. Estimated cost $26,000.